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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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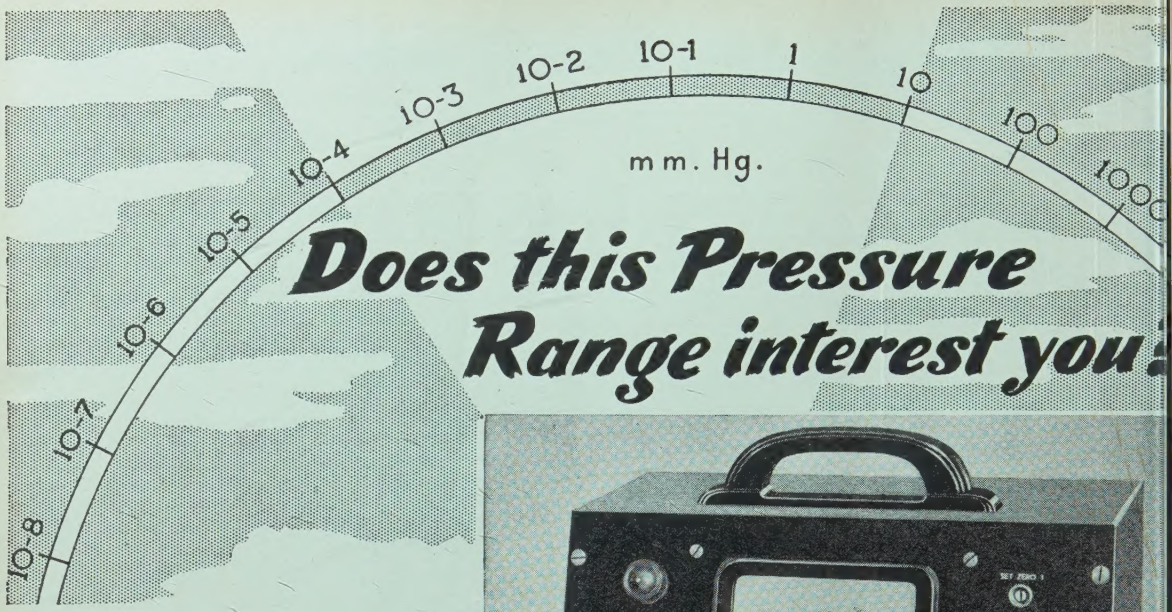
VOLUME 54 **MAY 1951** NUMBER 641



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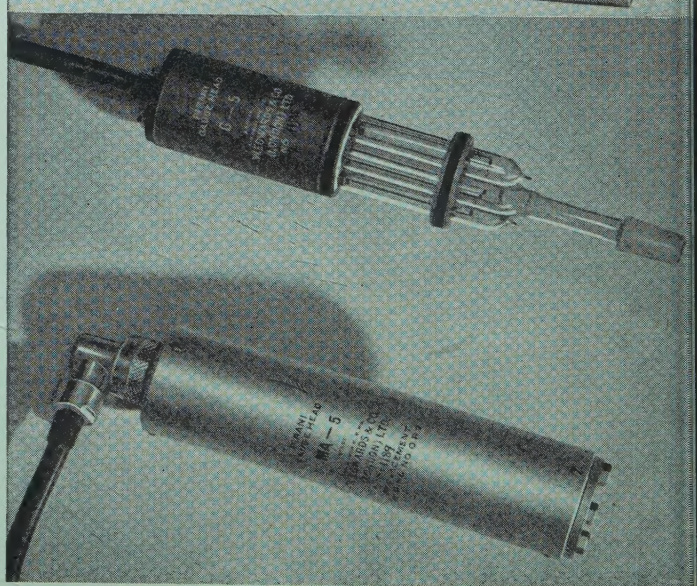

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
Industrial radiography
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplement published with the Index to Volume 53 (1950). Reprints of the List of Journals (1950) and the Supplement (1950) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

Atomics, Lond.	*Atomics.* [Alteration to entry in 1950 List.]
Bell Lab. Rec.	*Bell Laboratories Record.* Bell Telephone Laboratories, 463 West Street, New York 14, N.Y. [Change of address.]
Ber. Verh. Sächs. Akad. Wiss. Lpz, Math.-nat. Kl.	*Berichte über die Verhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig.* S. Hirzel Verlag, Birkenwaldstrasse 285, Stuttgart N.
Bull. Un. Exploit. Elect. Belge	*Bulletin de l' Union des Exploitations Electriques en Belgique.* 63 Rue Ducale, Brussels.
Centen. Proc. Roy. Met. Soc.	*Centenary Proceedings of the Royal Meteorological Society.* 49 Cromwell Road, London, S.W.7.
Glasn. Mat.-fiz. Astr.	*Glasnik Matematičko-fizički i Astronomski* [*Periodicum Mathematico-physicum et Astronomicum*]. Hrvatski-Prirodoslovno Društvo [Societas Scientiarum Naturalium Croatica]. Marulicev trg 19, Zagreb.
**John Crerar Libr. Bibl.*	*John Crerar Library Bibliography.* John Crerar Library, 86 East Randolph Street, Chicago 1, Illinois.
Mem. Fac. Engng Kyoto Univ.	*Memoirs of the Faculty of Engineering, Kyoto University.* Kyoto.
**Monogr. Ser. Res. Inst. Appl. Phys.*	*Monograph Series of the Research Institute of Applied Electricity.* Hokkaido University, Sapporo.
Nachrichtentechnik	*Nachrichtentechnik* [*Wissenschaftliche Beilage der Zeitschrift "Elektrotechnik" für das Gebiet der Fernmelde und Radiotechnik*]. Verlag Technik, Dorotheenstrasse 41, Berlin, N.W.7. [Issued as inset in "*Elektrotechnik*" until issue of October, 1951.]
Rev. Jeumont	*Revue Jeumont.* Forges et Ateliers de Construction Electriques de Jeumont, Jeumont (Nord).
Sci. Pap. Osaka Univ.	*Scientific Papers from the Osaka University.* Nakanoshima, Osaka.
Smit. Meded.	*Smit Mededelingen.* [Alteration to entry in 1950 List.]
Stockholms Obs. Ann.	*Stockholms Observatoriums Annaler.* Kungl. Vetenskapsakademiens Biblio tek, Stockholm 50. [Change of address.]
**Z. Elektrochem. angew. phys. Chem.*	*Zeitschrift für Elektrochemie und angewandte physikalische Chemie.* Verlag Chemie, Weinheim/Bergstrasse.
Z. wiss. Mikr.	*Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik.* S. Hirzel Verlag, Birkenwaldstrasse 285, Stuttgart N.

ABSTRACTING JOURNAL

ELEKTROTECHNIK, BERLIN	Verlag Technik, Dorotheenstrasse 41, Berlin, N.W.7.

MATHEMATICS 51

517.38

3250. Table of integrals. II. Definite integrals. [Integraltafel. Zweiter Teil. Bestimmte Integrale]. W. GRÖBNER AND N. HOFREITER. *Vienna, Springer-Verlag*, (1950) 204 *pp.*

Of the same form as Part I [Abstr. 2269 (1949)] this set of tables contains 5 sections comprising: Rational integrands; Algebraically irrational integrands; Elementary transcendental integrands; Eulerian integrals; Integrals of cylindrical functions.

517.432.1 : 621.3.01

3251. Finite representation of impulse functions. J. J. SMITH AND P. L. ALGER. *Elect. Engng, N.Y.*, **70,** 143 (*Feb.*, 1951).

Various mathematical properties of the Heaviside Null Unit Function, and its derivatives, are discussed, from an elementary point of view. The function is useful in transient problems, e.g. closing of a switch, sudden loading of a machine, or application of an impulse to some system. L. S. GODDARD

517.51 : 539.132

3252. The evaluation of integrals occurring in the theory of molecular structure. I–II. M. P. BARNETT AND C. A. COULSON. *Philos. Trans A, No.* 864, 221–49 (1951).

A new technique is developed in Part I for evaluating the integrals which occur in molecular theory. The method is based on the expansion of exponentials in terms of the so-called ζ functions. These involve modified Bessel functions. The properties of these ζ functions needed for the two-centre integrals are listed. A table is provided of the I's and K's used in their tabulation. An account is given of the properties of certain integrals of the ζ functions and some numerical examples are provided. In Part II, methods are described for the evaluation of the two-centre, one-electron Coulomb, overlap and resonance integrals, for the two-electron Coulomb and hybrid (Coulomb-exchange) integrals, and for the penetration integrals. Formulae are listed for more than 180 distinct integrals. A.

517.512

3253. Average value of periodic functions. M. SANTORO. *Elettrotecnica*, **37,** 450–6 (*Oct.*, 1950) *In Italian.*

The mean absolute value is defined, being the average of the absolute value of the function over one period. Its analytical expression is derived from the Fourier expansion of the function, both for even and odd functions. The mean absolute value of the sum of two arbitrary periodic functions is also evaluated. L. PINCHERLE

517.522

3254. Transformations to speed the convergence of series. J. B. ROSSER. *J. Res. Nat. Bur. Stand., Wash.*, **46,** 56–64 (*Jan.*, 1951).

Numerical instances are given of the speeding of the convergence of series by the Euler transformation. This is even applied advantageously to certain divergent series, and a rigorous justification is given. An example is given of a series for which use of the Euler transformation is not useful. Instances are given of several less widely known methods. Finally, the method of summation by transformation into a continued fraction is illustrated successfully in the case of certain divergent series. The possibility of applying two different methods in succession to a given series is exploited throughout the paper, in spite of the fact that this often requires summing a divergent series. A.

517.93

3255. A generalization of reversion formulae with their application to non-linear differential equations. A. C. SIM. *Phil. Mag.*, **42,** 228–38 (*March*, 1951).

The formulae for algebraic reversion are extended to revert a class of non-integral power series, and also generalized to revert series in which the coefficients contain operators. These formulae are shown to have a simple and powerful application to non-linear differential equations, which they expand into an infinite sequence of linear equations. A.

518.12

3256. Checking and interpolation of functions tabulated at certain irregular logarithmic intervals. H. E. SALZER. *J. Res. Nat. Bur. Stand., Wash.*, **46,** 74–7 (*Jan.*, 1951).

Many functions $f(x)$ behave as polynomials in $\log x$. When tabulated for arguments in geometric progression, $f(x)$ can be checked by ordinary differencing, and interpolation can be performed to a fine extent with existing tables of Lagrangian coefficients. But in practice, $f(x)$ is often known or calculated at some or all of the points 1, 2, 5, 10, 20, 50, 100, 200, 500 and 1 000 (same theory for the points 0·001, 0·002, 0·005, 0·01, etc., or 0·01, 0·02, 0·05, 0·1, etc., or any constant multiple of 1, 2, 5, . . .). The present tables have a twofold use: I. Checking the correctness of $f(x)$ when tabulated at some of the more frequently occurring combinations of points 1, 2, 5, etc. This also includes their use to estimate the least number of tabular entries for interpolation of given accuracy. II. Facilitation of Lagrangian interpolation by a generalization of a scheme given by W. J. Taylor. A.

518.4 : 621.3.011.2

3257. Logarithmic chart for complex and oscillation calculations. W. DE BEAUCLAIR. *Bull. Ass. Suisse Elect.*, **42,** 18–25 (*Jan.* 6, 1951) *In German.*

By plotting the amplitude of a complex number along one axis, and the log of its modulus along a perpendicular axis, a chart is obtained by which multiplication of complex numbers is carried out by vector addition. By applying further conformal transforms to this network, functions of the numbers, instead of the numbers themselves, may be multiplied.

Examples are given of numerical solutions of complex impedance problems by this means. N. CORCORAN

518.5 : 517.512.2 : 621.318.572

3258. A simple analogue computor for Fourier analysis and synthesis. J. H. BOWEN AND T. E. BURNUP. *Electronic Engng*, **23**, 67–9 (*Feb.*, 1951).

The transient response of an electro-mechanical system, for various types of input, may be obtained by analysing the frequency characteristic by the Fourier integral formula, forming the compound characteristic, and carrying out a Fourier synthesis. The response to a unit impulse input provides a laborious integral, and a computer is described for solving such integrals which employs a uniselector together with standard electrical components. Accuracy is demonstrated by an analysis of the response of a recording voltmeter. The computer can also be adapted to solve Fourier analysis problems.

A. J. KENNEDY

518.5 : 621.318.572

3259. An analogue computer for systems of linear differential equations, with special reference to problems of aircraft stability. B. QVARNSTRÖM. *Trans Instrum. Meas. Conf., Stockholm* (1949) 245–9 (1950).

Arrangements of feedback amplifiers are used to provide an immediate electrical analogue with any particular set of equations desired. Mathematical expressions are derived and the applications to methods of integration and summation given. A practical computer is described. E. H. W. BANNER (R)

518.5:621.318.572

3260. Special devices for differential analyzers. A. C. COOK, L. K. KIRCHMAYER AND C. N. WEYGANDT. *Elect. Engng, N.Y.*, **69**, 1080 (*Dec.*, 1950) [Digest of *Amer. Inst. Elect. Engrs Paper* **50–215** to be published in *Trans* **69** (1950)].

An automatic photoelectric curve follower has been developed for an existing analyser, together with a gear-ratio selector, remote indicator, transportation lag device (introducing certain functions encountered in control studies where a time lag exists between the sensing and the application of a signal) and a recording counter (providing tabulated numerical data).

A. J. KENNEDY (R)

518.5 : 621.318.572

3261. The graph-scope, an electronic graph plotter and graphical computer. A. L. THOMAS, JR. *Elect. Engng, N.Y.*, **69**, 1097 (*Dec.*, 1950).

A conventional sweep-trace on a c.r.o. is pulsed to plot the points, an extension of this permitting the plotting of continuous curves. The co-ordinate system desired (which is also drawn) may be selected, e.g. slope, length of axes; rectangular or polar plot; linear, logarithmic or hyperbolic division. Plotted curves (the data for these are fed in by a keyboard) may be compared with curves derived from an analogue computer and hence analyses made. Certain limitations of c.r.o. plotting and of the electronic circuits are outweighed by its rapidity and flexibility.

A. J. KENNEDY (R)

518.5 : 621.383 : 621.318.572

3262. Photoelectric analogue computer. E. C. KOENIG. *Electronics*, **23**, 124–6 (*Dec.*, 1950).

Certain features of photocell operation which can be conveniently adapted to a simple computer are surveyed. The instrument is briefly outlined: the photocells of its basic elements are excited from 6 separate light sources, around each of which are 10 radially positioned cells, each with its own aperture. 56 sources of unidirectional e.m.f. are available for connection anywhere in the circuit.

A. J. KENNEDY (R)

519.2 : 517.94

3263. Random walks and the eigenvalues of elliptic difference equations. W. WASOW. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 65–73 (*Jan.*, 1951).

This paper is concerned with the application of Monte Carlo methods to differential equations of the form, $\nabla^2 u + g(x,y)u = 0$. It is shown that under suitable conditions the Monte Carlo solution converges and gives the solution of the difference analogue of the above equation. A.

519.2 : 621.395.34

3264. Probability calculus in telecommunication. L. KOSTEN. *Voordr. K. Inst. Ing., No.* 1, 81–91 (1951).

Erlang's results are deduced for the probabilities of loss and delay of the full-availability group, and mathematical difficulties are discussed which arise in the restricted availability case. In order to avoid them, machines for fictitious traffic are constructed working on an analogy basis. The principle of the design of such a machine is outlined. A.

519.24 : 539.501

3265. The application of factor analysis to tests on cheese. R. HARPER AND M. BARON. *Brit. J. Appl. Phys.*, **2**, 35–41 (*Feb.*, 1951).

The basic principles of factor analysis are discussed. The technique is applied to the study of the relationship between a number of rheological tests and essential subjective judgments on cheese. The stability of the various "factors" is demonstrated by a comparison of two studies on groups of about 200 cheese made in successive seasons. The first two factors are shown to be closely related to measures of surface hardness (indentation by a loaded sphere) and subjectively assessed crumbliness, respectively. The remaining factors seem to be complex in origin, depending on arbitrary grouping in the tests and assessments selected. A.

519.281.2

3266. Approximation of an arc of a curve by some sine functions. W. ROMBERG. *Avh. Norske Vidensk. Akad. Oslo I. Mat.-Nat. Kl., No.* 3, 10 *pp.* (1949) *In German.*

The curve is given by experimental (numerical) data, and a method is discussed for fitting, to the curve, a Fourier sine series. A method of least-squares is used, and an approximate process for carrying out the calculations is discussed.

L. S. GODDARD

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.5/.6 : 523.748

3267. An experiment in phosphorphotography of solar protuberances in the infra-red. A. B. SEVERNYI. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 189–92 (1951) *In Russian.*

The intensity of solar protuberances was studied with a spectrohelioscope, and spectrographically using an interference-polarizing filter of quartz, described previously [Gilvarg and Severnyi, *Izv. Krim. Astrofiz. Obs.*, 6 (1950)]. The line chosen was the He line 10 830 Å corresponding to the transition 2^3P^0–2^3S in the "metastable" state of ortho He. Photographs of the protuberances were taken using a coronograph with only the aid of this filter and fused phosphors placed in contact with the emulsion of the photographic plate [for data on phosphors see *Dokl. Akad. Nauk, SSSR*, **54** (*No.* 1) (1946)]. Photographs were also taken which could be used for photometric measurements. Using the results obtained, the relative abundance of He to H_2 in these protuberances is found to be approx. 16%. Photographs are included. W. HUGHES

522.61 : 523.855

3268. Photometry of the galaxies by the Fabry method. J. BIGAY. *C.R. Acad. Sci., Paris*, **232**, 312–14 (*Jan.* 22, 1951) *In French.*

The results from Fabry-photograms of 175 extra-galactic nebulae show a systematic magnitude difference from those for the same nebulae derived by other (photographic and photoelectric) methods. Fabry magnitudes, in general, are brighter by amounts from $0{\cdot}4^m$ to as much as $2{\cdot}0^m$ (the former are compared with extra-focal, and the latter with direct photographic images). Only for Mt. Wilson photoelectric measures, based on observations with diaphragms comparable with those used for the Fabry measures, is agreement satisfactory, with no appreciable systematic difference. D. R. BARBER

522.615

3269. A photoelectric stellar photometer. F. LENOUVEL. *C.R. Acad. Sci., Paris*, **232**, 385–7 (*Jan.* 29, 1951) *In French.*

A discussion of the performance of the photometer used with the 120 cm telescope at Haute-Provence; the Sb–Cs cell with 19 multipliers is used with two colour filters. A typical curve of a minimum of ST Per shows that the observational dispersion does not exceed 0·02 mag. M. W. OVENDEN

523.161

3270. Turbulence in the interstellar medium. L. H. ALLER. *Astrophys. J.*, **113**, 120–4 (*Jan.*, 1951).

The brightness variation in an extended region of emission nebulosity in Cygnus photographed with the Palomar 48 in Schmidt is analysed from the point of view of turbulence theory. The largest eddies appear to be about 5–10 parsecs in diameter. The character of the turbulence spectrum suggests that these large eddies possess a sufficient supply of energy to maintain an equilibrium spectrum. Further studies in this and other regions to fix the character of the turbulence spectrum are needed. A.

523.165 : 551.510.535

3271. The effects of the terrestrial ionosphere on the radio waves from discrete sources in the galaxy. M. RYLE AND A. HEWISH. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 381–94 (1950).

Observations of the discrete sources of radio waves in the galaxy have shown the existence of irregular refraction processes in the terrestrial ionosphere. These irregularities cause rapid fluctuations in the intensity of the radiation at the ground, whilst observations with aerials of high resolving power have shown, in addition, that the apparent position of a source may vary irregularly by 2–3 min of arc. The incidence of these irregularities shows a marked diurnal variation having a maximum at about 01 hr 00 min local time. It does not seem possible to account for the irregularities in the ionosphere in terms of solar emissions, and an alternative mechanism is proposed which is based on the interception of interstellar matter moving under the gravitational attraction of the sun. If this hypothesis is correct, further experiments may provide information of interest in theories of the accretion of matter by the sun. A.

523.2

3272. On the origin of the solar system. G. ARMELLINI. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)* **9**, 135–41 (*Sept.–Oct.*, 1950) *In Italian.*

The hypothesis that the planets separated from the sun, simply on account of an originally excessive solar angular velocity, is discussed in relation to difficulties arising from the comparatively large distances of planets from the sun, and from the present slow solar rotation. R. A. NEWING

523.32

3273. The temperature of the moon. J. J. RAIMOND, JR. *Hemel en Dampk.*, **48** (*No.* 5) 81–4 (*May*, 1950).

By measuring radiations in the near infrared (not absorbed by CO_2 as infrared are) the following surface temperatures have been determined for various phases of the moon: centre of full moon 100°C, centre of the new moon −150°C, average −24°C and interior −50°C or −60°C. Methods used by Piddington and Minett in Australia are described and illustrated.

METEOROLOGICAL ABSTRACTS

523.4

3274. On the instability of small planetary cores. I. W. H. RAMSEY. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 325–38 (1950).

The instability of small planetary cores, which was encountered in one of the author's previous papers [Abstr. 4295 (1949)], is investigated more fully. It is pointed out that the phenomenon may have a bearing on the origin of meteorites and asteroids. A.

523.4

3275. On the instability of small planetary cores. II. M. J. LIGHTHILL. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 339–42 (1950).

The property that, for a spherically symmetrical planet in which the density is a function of the pressure, 3 states of equilibrium are possible in a certain

range of values of the total mass, is shown to hold whenever the density is continuous up to a critical pressure p_c, at which (owing to a change of phase) it rises discontinuously by a factor exceeding $\frac{3}{2}$. The question of transitions between the states is briefly discussed. A.

523.4

3276. Problem of the dissipation of planetary atmospheres. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 193–6 (1951) *In Russian.*

The formula for the dissipation period of planetary gases which arises from the dynamical theory originally developed by Jeans and improved by E. Milne, J. Jones and L. Spitzer, though considered acceptable from the standpoint of general cosmogony, is found by the author to be extremely limited in applicability. It does not, for instance, in his view, explain the dissipation of the gas forming the main part of a "primitive" planet, where Jeans' "level of dissipation" is not reached. Nor does it apply to a time when He and other light gases were abundant in the earth's atmosphere. The article goes on to evolve an alternative formula, in conformity with the recent proof by S. B. Pikelner [Abstr. 6976 (1950)] that the dissipation of the corona of the sun and the stars has nothing to do with cosmogony. J. CLEUGH

523.41

3277. Observation of an atmosphere around the planet Mercury. A. DOLLFUS. *C.R. Acad. Sci., Paris*, **231,** 1430–2 (*Dec.* 18, 1950) *In French.*

Polarization measurements of small areas of the planet's surface, made at the Pic du Midi station, show that the polarization varies in the opposite sense to the albedo of the area. Distribution of polarization and its variation with spectral region indicate the existence of an atmosphere of thickness about 3×10^{-3} that of the earth. M. W. OVENDEN

523.51

3278. The theory of micro-meteorites. I. In an isothermal atmosphere. F. WHIPPLE. *Proc. Nat. Acad. Sci., Wash.*, **36,** 687–95 (*Dec.*, 1950).

A theory is developed to investigate the processes of dissipation by temperature radiation of the energy of collision by atmospheric molecules. The theory is applied to an isothermal atmosphere, and limiting dimensions for micro-meteorites which are stopped by the atmosphere without melting are calculated.

M. W. OVENDEN

523.72

3279. The solar atmosphere and the origin of radio-frequency radiation. S. A. KORFF AND Y. BEERS. Letter in *Phys. Rev.*, **80,** 489–90 (*Nov.* 1, 1950).

Some well-established considerations concerning "temperature" and equilibrium conditions on the sun are emphasized with particular reference to radio noise observations. It is pointed out that in solar and celestial noise measurements "temperature" is a convenient fiction with no direct physical significance.

W. J. G. BEYNON

523.72

3280. Ultra-violet emission from the chromosphere. R. V. D. R. WOOLLEY AND C. W. ALLEN. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 358–72 (1950).

A model of the quiet chromosphere is constructed which gives as good a fit as found possible to data from eclipse observations and to observations of solar radio noise and of the ionosphere, everything being taken at minimum solar disturbance. The model has spherical symmetry and a single value of the kinetic temperature at every height; there is a sharp division between the lower chromosphere, at heights below 6 000 km, in which the temperature is 5 040°, and the upper chromosphere in which the temperature ascends at first very rapidly. It is estimated that the chromosphere emits about 7×10^{14} quanta capable of ionizing terrestrial gases per cm^2 per sec, of which 6×10^{14} are emitted in line spectra of ions such as O VI, O V, N V, etc., and the remainder in the Lyman continuum of H. About half the quanta have an energy greater than 13·6 volts, and are therefore capable of ionizing O to O^+ in the ionosphere. The energy is supplied by conduction inwards from the corona. A.

523.72

3281. A study of solar radio disturbances of feeble intensity. E. -J. BLUM, J.-F. DENISSE AND J.-L. STEINBERG. *C.R. Acad. Sci., Paris*, **232,** 387–9 (*Jan.* 25, 1951) *In French.*

An oscillograph of time-constant 1/1 400 sec was used to record variations of solar radiation at frequencies in the neighbourhood of 164 Mc/s. On days of feeble intensity, the radiation arrives in bursts of duration 0·1 to 0·4 sec, and intensity on the average the same order as that of the base level (5×10^{-22} W/m^2/c/sec). The bursts are well separated, but show a tendency to occur in groups. It is shown that the radiation on active days is due to the superposition of a large number of individual bursts of a type similar to those observed separately on quiet days. W. M. OVENDEN

523.74

3282. On the characteristic numbers of solar activity. G. RIGHINI AND G. GODOLI. *Ann. Geofis.*, **3,** 501–13 (*Oct.*, 1950) *In Italian.*

A change of the scale of the characteristic numbers permits indexes proportional to the area covered by flocculi, etc., to be obtained. M. DOPORTO

523.74 : 538.3

3283. The question of the distribution of the electromagnetic field of spots in the sun's atmosphere. P. E. KOLPAKOV AND YA. P. TERLETSKIĬ. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 185–8 (1951) *In Russian.*

Theoretical. Experimental results which indicate the existence of an electrical field of spots in the middle and upper layers of the sun's atmosphere are quoted, and equations are deduced expressing the distribution of this field. It is shown that this field will be freely distributed in the sun's atmosphere and its magnitude at a certain distance from a spot will be defined as the quasi-static field of a magnetized object in a vacuum. The effect of the intermediate medium on the field will be negligible and consequently the electric field above the spots can be regarded as satisfying the following equations: $\text{rot}\, B = 4\pi\, \text{rot}\, I$ and $\text{rot}\, E = (\partial B/\partial t)$, where B is the induction of the magnetic field, I is the vector of magnetization in the region of the spots and E is the electrical component of the electromagnetic field of spots. See also Abstr. 3690 (1949).

W. HUGHES

523.746

3284. On the magnetic flux through sunspots. W. GROTRIAN AND H. KÜNZEL. *Z. Astrophys.*, **28** (*No.* 1) 28–42 (1950) *In German.*

Analysis of the observations of the polarity and field strength of sunspots obtained for the periods 1917–24 at the Mount Wilson Observatory and 1942–49 at the Einstein Tower telescope at Potsdam. The magnetic flux is calculated (*a*) for single spots, (*b*) for spot groups, and (*c*) for the whole disk of the sun, separating the northern and southern solar hemispheres. It is found that, for both hemispheres, the mean of all observed flux-values through the *p*-spots is about 3–4 times as large as that through the *f*-spots.

A. BEER

523.75

3285. Spectrophotometric classification of protuberances. M. WALDMEIER. *Z. Astrophys.*, **28** (*No.* 2) 208–18 (1951) *In German.*

A new classification of solar prominences is introduced, based on the intensity ratio of the lines Fe II 5 169·03 and Mg I 5 167·32. This ratio depends on the electron density and temperature in the prominence. Classifications have been made of 131 prominences. It is found that there are marked differences in this intensity ratio between prominences connected with sunspots and filaments occurring outside of spot groups. These differences are interpreted as variations of electron density and electron temperature. A.

523.77

3286. An investigation of the 2 943-cm^{-1} line of the solar spectrum. W. M. BENESCH, F. P. ELBY AND J. T. ELDER. Letter in *Phys. Rev.*, **81,** 145 (*Jan.* 1, 1951).

523.802

3287. On stellar statistics. S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **113,** 150–65 (*Jan.*, 1951).

In this paper a method is proposed for treating the fundamental equation of stellar statistics which will take into account the known cloud structure of the interstellar absorbing matter. The method is based on the determination and the interpretation of the fluctuations in the numbers of stars, $N(m)$, per unit solid angle, and brighter than a given apparent magnitude, m, in the various parts of the sky. The marked dependence of these fluctuations on the galactic latitude confirms their relation to the interstellar clouds. Theoretical formulae are derived for the dispersions to be expected in $N(m)$ as a function of the galactic latitude on certain idealized distributions of stars and clouds. The results of star counts tabulated by van Rhijn and by Baker and Kiefer are analysed in terms of these formulae, and a theoretical prediction based on them is verified. The analysis discloses the importance of taking into account the dispersion in the transparencies of the interstellar clouds as a factor in these considerations. A.

523.82

3288. The magnitude differences between the components of eighty-two spectroscopic binaries. R. M. PETRIE. *Publ. Dom. Astrophys. Obs., Vict.*, **8,** 319–40 (1950).

This paper gives the values of Δm, determined from spectrophotometric measures, for 82 spectroscopic binaries showing the spectra of both components. Spectral-type differences, relative radii, and relative mean densities are determined. Sources of error in the spectroscopic method are discussed. A comparison with eclipsing binary data determined from light-curves indicates that the systematic error of the measured Δm averages less than 0·1 mag. Spectroscopic notes, for each system, are appended. See also Abstr. 2008 (1941). A.

523.83

3289. Contribution to the study of stellar velocity distribution. J. DELHAYE. *Bull. Astron., Paris,* **16** (*No.* 1) 1–83 (1951) *In French.*

A critical survey of observational data from 26 regions of the celestial sphere, the latter divided into 3 zones: (1) N polar cap, +40° to +90° galactic lat.; (2) low latitude belt between +40° and −40°; and (3) S polar cap, −40° to −90°. Tables are given showing both zonal and spectral-type distributions of radial velocities for low and high latitudes, and for faint and bright stars. Definite evidence for "star streaming" is found in the constellations Ursa Major, Taurus and Scorpio-Centaurus. A useful bibliography is appended. D. R. BARBER

523.851

3290. Self-gravitating star systems. G. L. CAMM. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 305–24 (1950).

The Boltzmann equation for a star system in which the controlling forces are solely due to the gravitational attractions between the members is not strictly linear. For the restricted case of a system of stars of equal mass, stratified in plane parallel layers, the Boltzmann equation reduces to a non-linear partial differential equation in 3 independent variables. Three functions which satisfy this equation have been found. Two of these correspond to the equilibrium configurations of an isothermal self-gravitating gas, and of an adiabatic gas. The hypothetical models can be compared with the greatly flattened galactic system, and there is considerable agreement between the observed variation of density with distance from the galactic plane and the variation predicted by 1 of the 3 solutions. A.

523.854.2

3291. The pole of the galaxy as determined from measurements at 205 Mc/sec. C. L. SEEGER AND R. E. WILLIAMSON. *Astrophys. J.*, **113,** 21–49 (*Jan.*, 1951).

The position of the pole of the galaxy was determined from measurements of galactic radiation at a frequency of 205 Mc/s. The radiation is found to be highly concentrated along a small circle close to the galactic equator. The co-ordinates of the pole are 266·8° ± 4·5° galactic longitude and 87·43° ± 0·34° north galactic latitude, referred to the 1 900 I.A.U. pole. The small circle has a north polar distance, θ, of 91·28° ± 0·18°. The characteristics and calibration of the radio telescope employed in these measurements are described. The observational technique and the treatment of the data are presented in detail. There is a discussion of the sources of error in the observations and an analysis of the reliability of the results. Two alternative hypotheses are suggested to explain the serious deviations of θ from 90°. The first,

judged the less likely, would require changing the accepted height of the sun above the galactic plane from 10 or 20 parsecs to a value of several hundred parsecs. The alternative is to disregard the theoretical calculations of the opacity of the galaxy for the radiation at 205 Mc/s which have been made on the basis of currently used formulae representing free-free transitions in the interstellar medium as the sole source of the opacity. An observational value of approximately unity per kiloparsec is derived for the mean absorption coefficient in the plane of the galaxy at 205 Mc/s. A.

523.855

3292. On the stellar dynamics of spherical galaxies. J. BELZER, G. GAMOW AND G. KELLER. *Astrophys. J.*, **113**, 166–80 (*Jan.*, 1951).

The dynamical behaviour of stars in spherical galaxies is studied on the basis of Hubble's luminosity distribution, with the assumption that the mass of material along any line of sight is proportional to the surface luminous intensity. It is concluded that the stars within 3 parsecs of the centre have nearly random motion and may be in the state of dynamical equilibrium. On the other hand, it seems that at distances of more than 15 parsecs from the centre the motion of stars is largely radial. It is suggested that in the outer region statistical equilibrium may have been achieved with regard to the radial component of the stellar momenta. A.

523.87 : 523.162

3293. Intensities of the interstellar band at λ4430. D. DUKE. *Astrophys. J.*, **113**, 100–19 (*Jan.*, 1951).

The central absorption of the broad interstellar band centred near λ4430 has been measured in some 400 stars. When combined with spectroscopic parallaxes for the same stars, this material has made possible an investigation of the relationship between band intensity, on the one hand, and colour excess and interstellar line intensity, on the other. A good correlation with colour excess is found, and a much weaker one with distance; the correlation with the intensity of the interstellar *D* lines is intermediate between the other two. The band absorption appears to occur, in general, in regions where interstellar reddening is found; there are, however, some exceptions to the very close relationship between band absorption and reddening which seems to exist for the majority of the stars observed. A.

523.875

3294. The mass-luminosity relation determined from spectroscopic binaries. R. M. PETRIE. *Publ. Dom. Astrophys. Obs., Vict.*, **8** (*No.* 11) 341–55 (1950).

This paper presents a new derivation of the mass-luminosity relation from the measured Δm and mass-ratio in 93 spectroscopic binary systems [see Abstr. 3288 (1951)]. The advantages and weaknesses of this differential method are discussed. The analysis of the data gives the reciprocal slope of the mass-luminosity relation as $-0{\cdot}144 + 0{\cdot}003M$, valid from absolute magnitudes $+3$ to -5. Using the well-determined mass and luminosity of Sirius and the above relation, the relation is found to be $\log m = +0{\cdot}548 - 0{\cdot}144M + 0{\cdot}002M^2$. This is listed against eclipsing and visual binaries, not used in the derivation, with satisfactory results over the appropriate luminosity interval. The method is probably worth extending by the inclusion of data both from eclipsing binaries and particularly the visual binary systems. A.

523.875

3295. Intensity of the 4 300 Å band of the CH molecule in stellar spectra of types F, G, K, and M. TCHENG KIEN. *C.R. Acad. Sci., Paris*, **232**, 40–2 (*Jan.* 3, 1951) *In French.*

This band was measured in spectra of small dispersion (mostly 80 A/mm) taken at Haute-Provence. A plot of the results shows a regular intensity change from types F to M, with a maximum at G9 in agreement with Russell's prediction. Absolute magnitude effects are inappreciable. D. L. EDWARDS

523.877

3296. Models for red giant stars. I. General discussion and application to homogeneous models. C. M. BONDI. *Mon. Not. Roy. Astron. Soc.*, **100** (*No.* 4) 275–86 (1950).

The aim of this series of papers is to consider systematically all possible models for red giant stars from the mathematical point of view. This first paper gives a brief general discussion of the red giant problem and this is followed by a consideration of the mathematically simplest case, that of homogeneous models. It is shown that if present views on opacity laws in stars are correct, no homogeneous model provides an adequate explanation of the red giant phenomenon. A.

523.877

3297. Models for red giant stars. II. Models with a chemical inhomogeneity and opacity due to photo-electric effect. C. M. BONDI AND H. BONDI. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 287–304 (1950).

This paper presents a complete survey of the range of models that can be constructed using the opacity law $\kappa \sim \rho^{0{\cdot}75}T^{-3{\cdot}5}$ and possessing a single chemical discontinuity. It is shown that for physically possible changes of molecular weight, large and even theoretically infinite radii are possible with only a moderate proportion of the whole mass in the outer envelope. The whole system of models is surveyed and mapped diagrammatically in homology-invariant variables, thereby showing the ranges of the various parameters important to the red giant problem. The solutions recently given by Li Hen and Schwarzschild, while numerically correct, are shown to be unrepresentatively distributed and confined to the less interesting part of the diagram. The outer regions of stars of large radii are further considered, and it is concluded that breakdown of the opacity law is likely to set a physical upper limit to the actual radii of red giant stars. A.

523.877

3298. Radiation field of extended stellar atmospheres. S. MIYAMOTO. *Astrophys. J.*, **113**, 181–92 (*Jan.*, 1951).

The problem of the radiation field in an extended atmosphere in which the transformation of ultraviolet radiation into Lyman-α radiation is taking place is considered. In treating this problem the Lyman-α contour is assumed to consist of a core and a wing with different absorption coefficients; also, account is taken of the ionization from the second quantum state. It is shown that both these effects reduce the transformation into Lyman-α to an extent

that the pressure resulting from the radiation is comparable to that due to the ultraviolet radiation. However, it appears that in the outermost parts of the nebula radiation pressure due to Lyman-α may be 100 times that of the ultraviolet radiation. For planetary nebulae the main effect comes from the contour's not being strictly rectangular, while in the atmospheres of Be stars the ionization from the second quantum state is the principal factor. The two effects are comparable when the dilution factor is about 0·0016. A.

523.877 : 523.841

3299. Physical characteristics of some classes of variable stars. L. Rosino. *Nuovo Cim.*, **8**, 54–61 (*Jan.*, 1951) *In Italian.*

It is shown that the precision of the physical parameters determined from the observed material is not sufficient to test the quantitative theory of a relationship between intrinsic variables and thermonuclear processes depending on Li, Be and B. Some strong objections are raised against the hypothesis that the energy sources of red supergiant and giant stars may be found on subatomic Li–Be–B processes. A.

523.877 : 534.222.2

3300. Propagation of shock waves in the generalized Roche model. P. A. Carrus, P. A. Fox, F. Haas and Z. Kopal. *Astrophys. J.*, **113**, 193–209 (*Jan.*, 1951).

The aim of the present paper has been to investigate the events which take place if the core of a generalized Roche model is made to expand as the result of an instantaneous central explosion. A sudden expansion of the core sets off a wave of condensation travelling through the envelope; and, if the initial explosion has been sufficiently strong, the outgoing disturbance will possess the characteristics of a shock wave. It is shown that, if the initial explosion has been instantaneous, the velocity, pressure and density at any point of the disturbed medium can be made to depend on a single parameter, $\xi = r^{-3}t^2$, where t denotes the time and r the radial distance. The equations of the problem have been rewritten in terms of ξ as the sole independent variable and integrated numerically for 18 cases corresponding to different Mach numbers of the shock waves and different ratios, γ, of specific heats of the gas constituting the envelope. The expanding regime forms a concentric shell, limited on the outside by the shock front of radius varying as $t^{2/3}$, while the interface of the core exhibits a "contact discontinuity." For large values of the Mach number M, the thickness of the shell increases with increasing M and decreasing value of the ratio of specific heats; for $\gamma = \frac{4}{3}$ (corresponding to polyatomic gas) the radius of the core becomes zero for any strength of the shock. It is shown that, for $\gamma = \frac{5}{3}$ (corresponding to monatomic gas), a shock wave characterized by $M = 2{\cdot}877\ldots$ is just sufficiently strong to endow the mass particles immediately behind it with a velocity equal to one of escape from the gravitational field of the configuration, while for $M > 5{\cdot}92\ldots$ the whole envelope will eventually be ejected. A.

523.877 : 539.172.13

3301. Note on the proton-proton reaction in white dwarf stars. T. D. Lee. Note in *Astrophys. J.*, **112**, 561–2 (*Nov.*, 1950).

It is shown that in white dwarf stars the process $He^3 + e^- \rightarrow H^3 + \nu$ will always be much more probable than the transformation $He^3 + He^4 \rightarrow Be^7 + \gamma$. M. W. OVENDEN

525.3

3302. Influence of the solar magnetism on the motion of rotation of the earth. C. Agostinelli. *Geofis. Pura Appl.*, **18** (*No.* 1) 18–37 (1950) *In Italian.*

The interaction between the magnetic field of the sun, due to sunspots and the phenomena of the corona, and the magnetic field of the earth is considered; the influence on the motion of rotation of the earth is examined, and the formulae which give the variation of its angular velocity of rotation and of the angles of nutation and of precession are fixed. A.

526.1

3303. On the fundamental relation of dynamical geodesy. L. Bragard. *Bull. Soc. Roy. Sci. Liège*, **19**, 475–8 (*Nov.*, 1950) *In French.*

Discusses the relation between the form of an equipotential surface of a rotating body and the value of gravity on the surface. A. H. COOK

526.1

3304. On the determination of the equilibrium figure of a fluid mass in uniform rotation. L. Bragard. *Bull. Soc. Roy. Sci. Liège*, **19**, 479–84 (*Nov.*, 1950) *In French.*

Extends the theorem described in the preceding Abstr. to the external surface of a rotating mass of fluid. A. H. COOK

526.2 : 535.8

3305. The electric eye. E. Gigas. *Geofis. Pura Appl.*, **18** (*No.* 1) 113–19 (1950).

An account of work in progress at the *Institut für angewandte Geodäsie* on the development of photoelectric indication to take the place of visual observation in geodetics surveying in unfavourable atmospheric conditions. Photographs are given of an apparatus which has given promising results, though further development is needed to make it thoroughly reliable for field use. A.

526.7

3306. The geodetic uses of gravity measurements and their appropriate reduction. J. de Graaff-Hunter. *Proc. Roy. Soc. A*, **206** 1–17 (*March* 22, 1950).

States the needs of geodesy which must be met to allow results to be expressed in one unique reference system. At present the great surveys are in disconnected systems and are partially spheroidal and partially geoidal. A theorem of Stokes, relating geoid with spheroid, is recalled and expressions for the deviations of the vertical and the curvature of the geoid are deduced. All these are in the form of integrals of the gravity anomalies over the earth. This ideal earth is a body bounded by a level surface, and to bring the actual earth into its scope, protuberances of the topography above the co-geoid—a surface differing slightly from the geoid—must be annulled. The relation between gravity at different levels is found in terms of the local mean geoidal curvature, instead of the customary mean of the

whole earth. A practical observational method of finding this curvature is proposed, depending on reciprocal vertical angles observed at pairs of points; atmospheric refraction difficulties are discussed. A.

526.92 : 621.317.39

3307. The effect of meteorological conditions on the measurement of long distances by electronics. C. I. Aslakson and O. O. Fickeissen. *Trans Amer. Geophys. Un.*, **31**, 816–26 (*Dec.*, 1950).

In the measurement of long distances by electronic methods, meteorological observations are needed for two reasons: (1) The changing index of refraction of the atmosphere with altitude between the ground station and the aircraft bends the ray path, changing the length of the path, thereby necessitating a varying correction to reduce the measured distance to a geodetic distance. (2) A constant velocity of propagation of electromagnetic waves is assumed in the instrument design. The true velocity of the waves varies with changing meteorological conditions, and a correction, which is a function of the difference between the assumed and the true velocities, must be applied to reduce the indicated distance to the true distance. This paper discusses these two effects and methods currently in use for determining these corrections. A.

PHYSICS 53

53.081.6 : 519.281.2

3308. A new formulation of the least-squares calculation of atomic constants. J. A. Bearden and H. M. Watts. Letter in *Phys. Rev.*, **81**, 160–1 (*Jan.* 1, 1951).

53.081.6 : 519.281.2

3309. Nonindependent observational equations in the theory of least squares. E. R. Cohen. Letter in *Phys. Rev.*, **81**, 162 (*Jan.* 1, 1951).

53.085.4

3310. Estimation of tenths of scale readings. H. Bäckström. *Trans Instrum. Meas. Conf., Stockholm* (1949) 195–200 (1950).

Analyses were made by many observers using cards marked in decimal divisions and the results are discussed statistically. Some practical results are suggested, such as best proportions of scale marks and widths, etc. E. H. W. BANNER

FUNDAMENTALS 530.1

530.12

3311. Surface area and electrodynamic boundary conditions for moving bodies. H. Epheser and T. Schlomka. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 211–20 (1950) *In German.*

A 4-dimensional representation is given of the following quantities: the distance between two points of the body, the surface element of area, the unit vector $\mathbf{n}$ describing the normal to the surface element, and surface charge and current densities. A new relativistic factor $\{1 - (\mathbf{u} \cdot \mathbf{n}/c)^2\}^{-1/2}$ is introduced, where $\mathbf{u}$ is the velocity vector. The electrodynamic boundary conditions are derived by application of the general Lorentz transformation to the 3-dimensional boundary conditions valid when $\mathbf{u} = 0$, or, more simply, by means of direct 4-dimensional formulation of these conditions. E. P. WOHLFARTH

530.12

3312. The equations of Einstein's new unified relativistic theory in the first approximation. P. Udeschini. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 256–61 (*Nov.*, 1950) *In Italian.*

The tensor g_{ik} is written as $a_{ik} + b_{ik}$, where a_{ik} is the Minkowski metric and the b_{ik} are small quantities whose squares are neglected. To this approximation the field equations separate into the usual gravitational field equations and the Maxwell electromagnetic equations for empty space. R. A. NEWING

530.12

3313. Consideration of two postulates of relativity. Special theory. M. Galli. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 262–7 (*Nov.*, 1950) *In Italian.*

530.12

3314. Gravitation and magnetism. E. A. Milne. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 4) 266–74 (1950).

It is shown by the methods of kinematic relativity that there should be a connection between gravitation and magnetism of the type suggested by the empirical formulae of Blackett and Wilson, multiplied, however, by certain dimensionless ratios. The field of a rotating system cannot be represented by a dipole. The derivation only applies rigorously to a rotating system like a galaxy, with its centre at a fundamental particle. The results obtained suggest that for a given mean density and given angular momentum, a highly flattened system should have an effective magnetic moment greater than a less flattened system. A.

530.12

3315. A geometrical model for the unified theory of physical fields. J. I. Horváth. Letter in *Phys. Rev.*, **80**, 901 (*Dec.* 1, 1950).

Gravitational and electromagnetic fields are related to the curvature and torsion of a Finsler space whose metric is $ds = L(x^i, \dot{x}^i)dt$, the usual metric tensor g_{ik} becoming $g_{ik}(x^i, \dot{x}^i) = \frac{1}{2}\partial^2(L^2)/\partial\dot{x}^i\partial\dot{x}^k$. R. A. NEWING

530.12

3316. On the impossibility of a stationary closed universe [with zero cosmological constant]. D. Aufenkamp. *C.R. Acad. Sci., Paris*, **232**, 213–14 (*Jan.* 15, 1951) *In French.*

530.12

3317. Equations of motion in general relativity. II. The coordinate condition. A. Papapetrou. *Proc. Phys. Soc., Lond. A*, **64**, 302–10 (*March*, 1951).

The paper contains a discussion of the necessity for using a co-ordinate condition in the calculations for the derivation of the equations of motion from the field

equations. It is found that no co-ordinate condition is necessary in the first approximation; i.e. one gets the Newtonian equations of motion if one merely assumes that the gravitational field is weak and quasi-static. In the higher approximations a co-ordinate condition is indispensable in order to eliminate all apparent accelerations from the equations of motion. A.

530.12 : 531.51

3318. The geometries of the thermal and gravitational fields. H. P. ROBERTSON. *Amer. Math. Monthly*, **57**, 232–45 (1950).

Gravitation is discussed in terms of a four-dimensional scalar theory, but the main ideas of Einstein's general theory are stressed. The results regarding the motion of test particles and the behaviour of light rays are stated and compared with those of Einstein's theory. The geometry of the thermal field is discussed in terms of measurements made by rods after they have been allowed to come into thermal equilibrium with a heated medium. In the latter case the geometry depends on the material composing the measuring rods, but in the gravitational case the geometry is universal because of the equivalence between inertial and gravitational mass.

MATHEMATICAL REVIEWS

530.145

3319. Perturbation calculations in quantum mechanics. M. MAYOT. *C.R. Acad. Sci., Paris*, **231**, 1426–8 (*Dec.* 18, 1950) *In French.*

The matrices arising in the quantum mechanics of complex molecules are hermitian with many zero elements; for the characteristic polynomials can be formed explicitly by a recurrence relation for the characteristic polygons of simpler matrices. The results are expressed in Chebyshev polynomials.

J. JACOBS

530.145

3320. Remarks on relativistic quantum mechanics. K. V. ROBERTS. Letter in *Phys. Rev.*, **81**, 158–9 (*Jan.* 1, 1951).

A summary is given of the conclusions reached in a theory which first extends the classical theory of Weiss and then quantizes the extension by a generalization of the usual rules. Earlier results have been modified in several important respects [Abstr. 2913 (1950)]. G. J. KYNCH

530.145

3321. On the connection between field equations and equations of motion. A. E. SCHEIDEGGER. *Helv. Phys. Acta*, **23** (*No.* 6–7) 740–4 (1950) *In German.*

It is shown that an application of Bergmann's generalization of Einstein–Infeld's technique to non-linear field equations cannot, in general, yield equations of motion for the sources in the scalar and vector cases, but that this is possible when the field variables constitute a tensor. J. R. MADDOX

530.145

3322. On the positron theory of vacuum. Y. KATAYAMA. Letter in *Progr. Theor. Phys.*, **5**, 906–7 (*Sept.–Oct.*, 1950).

530.145 : 535.14

3323. Transformation of configurations of a radiation field. Application to the radiation of multipoles. J. A. BALSEIRO. *Revista Un. Mat. Argentina*, **14**, 64–78 (1949) *In Spanish, with English Summary.*

The problem of determining the photon distribution over the states of a quantized radiation field, described by means of two systems of orthogonal vibrations both referred to the same radiation field, is solved. The formalism is applied to find the probabilities of a given configuration of the radiation emitted by electric and magnetic multipoles. Known expressions for angular intensity distributions are obtained. MATHEMATICAL REVIEWS

530.145

3324. Remarks on Bloch's method of sound waves applied to many-fermion problems. S. TOMONAGA. *Progr. Theor. Phys.*, **5**, 544–69 (*July–Aug.*, 1950).

The fact implied by Bloch several years ago that in some approximate sense the behaviour of an assembly of Fermi particles can be described by a quantized field of sound waves in the Fermi gas, where the sound field obeys Bose statistics, is proved in the one-dimensional case. This fact provides us with a new possibility of treating an assembly of Fermi particles in terms of the equivalent assembly of Bose particles, namely, the assembly of sound quanta. The field equation for the sound wave is found to be linear irrespective of the absence or presence of mutual interaction between particles, so that this method is a very useful means of dealing with many-fermion problems. It is also applicable to the case where the inter-particle force is not weak. In the case of force of too short a range this method fails. A.

530.145

3325. On the theory of electromagnetic bremsstrahlung. G. PETIAU. *C.R. Acad. Sci., Paris*, **232**, 153–5 (*Jan.* 8, 1951) *In French.*

See Abstr. 1612 (1951). A perturbation method is used to determine the cross-section for emission of bremsstrahlung by two distinguishable particles. The effects of recoil and emission of the photon are included in the calculation. S. MICHAELSON

530.145

3326. Nuclear saturation phenomena deducible from pair theories. G. WENTZEL. *Progr. Theor. Phys.*, **5**, 584–99 (*July–Aug.*, 1950).

Previous work on the same topic is extended, especially to include interactions involving the nuclear spins or isotopic spins in the static limit. For the discussion of such theories, a strong coupling approximation is used. The results vary widely with the coupling type assumed, resembling single particle models of nuclear structure in some cases, and liquid drop models, in particular the α-particle model, in other cases. A.

530.145

3327. A new type of perturbation. G. ALLARD. *J. Phys. Radium*, **11**, 646–52 (*Dec.*, 1950) *In French.*

The interaction term introduced by Pauli, which takes into consideration an intrinsic magnetic moment of the particle, may be considered as deriving from the vector product of the symbolic vector $p + eA/c$ with itself. It is suggested that one may introduce a pseudo-vector and a pseudo-scalar term formed in an analogous way. In the case of a Coulomb field the latter vanishes, while the former takes a form similar

to that introduced originally by Uhlenbeck and Goudsmit in the theory of the spinning electron. This term displaces the $^2P_{1/2}$ from the $^2S_{1/2}$ terms of H, but the intrinsic moments that would account for the experimental values of the displacement appear to be too large. The law of variation of the displacement with Z and n is on this theory the same as that obtained by Bethe. L. PINCHERLE

530.145

3328. On de Broglie's subtractive field and Feynman's interaction function. A. VISCONTI. *C.R. Acad. Sci., Paris*, **232**, 217–19 (*Jan.* 15, 1951) *In French.*

530.145

3329. Renormalization of the meson-proton-nucleon interaction. P. T. MATTHEWS. *Phil. Mag.*, **42**, 221–7 (*March*, 1951).

It is shown by direct calculation to fourth order in the coupling constants that all divergences, except those arising from the scattering of mesons by mesons, can be removed from the combined interaction of charged spinless mesons, nucleons (scalar interaction) and the electromagnetic field by mass and "charge" renormalization. The remaining divergence can be cancelled to this order by assuming a direct interaction between mesons with a suitably chosen coupling constant. A.

530.145

3330. A covariant formulation of the Bloch–Nordsieck method. W. THIRRING AND B. TOUSCHEK. *Phil. Mag.*, **42**, 244–9 (*March*, 1951).

The results of the Bloch–Nordsieck method are derived in a covariant manner, based on a covariant form of the commutation-relations in momentum space. A.

530.145 : 539.152.1

3331. On the nucleon-nucleon interaction. R. JASTROW. *Phys. Rev.*, **81**, 165–70 (*Jan.* 15, 1951).

A charge-independent interaction between nucleons is assumed, which is characterized by a short-range repulsion interior to an attractive well. It is shown that it is then possible to account for the qualitative features of currently known n–p and p–p scattering data. Some of the implications for saturation are discussed. A.

530.145

3332. Dirac's equation in a Riemann space with an asymmetrical metric. M. EL NADI. Letter in *Phys. Rev.*, **81**, 159–60 (*Jan.* 1, 1951).

530.145

3333. On the equivalence of pseudoscalar and pseudovector coupling constants in pseudoscalar meson theory. M. SUGAWARA AND Y. ÔNO. Letter in *Progr. Theor. Phys.*, **5**, 901–2 (*Sept.–Oct.*, 1950).

530.145

3334. On the radiation reaction in classical meson theory. H. STEINWEDEL. *S.B. Heidelberg. Akad. Wiss. (Math.-Naturwiss. Kl.) No.* 5, 275–80 (1950) *In German.*

The reaction force is calculated for a classical meson field in analogy with Dirac's method in electrodynamics of taking half the difference between the retarded and advanced potentials at the position of the radiating particle [*Proc. Roy. Soc., Lond. A*, **167**, 148 (1938)]. For a periodically oscillating nucleus (frequency ω) the result is

$$\frac{2}{3}\frac{g^2}{c^3}\frac{d^3r}{dt^3}\left[1-\left(\frac{c\kappa}{\omega}\right)^2\right]^{\frac{1}{2}}\left[1+\frac{1}{2}\left(\frac{c\kappa}{\omega}\right)^2\right]$$

for $|\omega| > \kappa c$ and 0 for $|\omega| < \kappa c$, where g = meson "charge", κ^{-1} = meson range (non-relativistic limit). W. J. SWIATECKI

530.145

3335. The classical meson dynamics as an action at a distance theory. H. STEINWEDEL. *S.B. Heidelberg. Akad. Wiss. (Math.-Naturwiss. Kl.) (No.* 5) 281–6 (1950) *In German.*

In analogy with the case of electrodynamics [Abstr. 733 (1946), 3752 (1950)] it is shown how the dynamics of classical meson theory can be restated as an action-at-a-distance theory. The appropriate action principle [in analogy with K. Schwarzschild, *Göttingen Nachrichten, pp.* 128, 132 (1903)] is found explicitly, but the resulting equations of motion are complicated integro-differential equations: the radiation reaction depends on the entire world line of the particle. The case of (slow) periodic vibrations is solved explicitly [see preceding Abstr.]. W. J. SWIATECKI

530.145

3336. High energy nuclear events. E. FERMI. *Progr. Theor. Phys.*, **5**, 570–83 (*July–Aug.*, 1950).

A statistical method for computing high-energy collisions of protons with multiple production of particles is discussed. The method consists in assuming that as a result of fairly strong interactions between nucleons and mesons the probabilities of formation of the various possible numbers of particles are determined essentially by the statistical weights of the various possibilities. A.

530.145

3337. The S-matrix in meson theory. NING HU. Letter in *Phys. Rev.*, **80**, 1109–10 (*Dec.* 15, 1950).

For pseudoscalar mesons with pseudoscalar coupling to nucleons the effect of the self-energy in any process is obtained by replacing the D_F function for the meson by $D_F/(1 - D_C D_F)$, where D_C is the lowest self-energy term after renormalization. The condition of convergence is now $E_m + \frac{3}{2}E_n - 4 \geqslant 1$, where E_m and E_n are the numbers of meson and nucleon lines respectively, as for the electromagnetic field. G. J. KYNCH

530.145

3338. On the production of π-mesons in nucleon-nucleon collisions (pseudoscalar theory). J. PRENTKI. *C.R. Acad. Sci., Paris*, **231**, 1434–6 (*Dec.* 18, 1951) *In French.*

A Feynman treatment of the production of particles (π-mesons) through interaction between nucleons in pseudoscalar-pseudoscalar coupling theory. The ratios of π^+ to π^- particles is found to be 2 : 1, in contrast to the experimental value (Berkeley) of 4 : 1. It is further concluded that a theory of nuclear forces requires a theory symmetrical between charged and neutral particles. J. R. MADDOX

530.145

3339. Note on the relation between Feynman's formulation of scattering problems and the Born approximation. J. R. H. DEMPSTER. *Canad. J. Phys.*, **29**, 66–71 (*Jan.*, 1951).

Feynman's formulation is described briefly, and is compared with Born's approximation. The two procedures are shown to be equivalent and to be valid under the same conditions. Feynman's formulae are used to calculate the first- and second-order terms of the scattered particle wave function, with an arbitrary scattering potential. A.

530.145.6

3340. The singular functions of the Klein–Gordon equation, taking account of an external magnetic field. J. GÉHÉNIAU. *Physica*, **16**, 822–30 (*Dec.*, 1950) *In French.*

The singular solutions of the relativistic equation of Schrödinger, for a particle with a charge e, rest mass m, placed in a uniform and constant magnetic field, are given in various forms without any approximation in relation to this field. A.

530.145.6

3341. Theorem on the invariant formed from four Dirac wave functions. L. MICHEL. *C.R. Acad. Sci., Paris*, **232**, 391–3 (*Jan.* 29, 1951) *In French.*

530.145.6 : 531.314.3

3342. The quantum mechanics of non-holonomic systems. R. J. EDEN. *Proc. Roy. Soc., A*, **205**, 583–95 (*March* 7, 1951).

Interactions of a non-holonomic type are fundamentally different from interactions which can be treated as part of the Hamiltonian of a system. They usually lead to constraints which do not commute with the Hamiltonian, and cause important alterations in the development of a state vector. This paper deals with the Heisenberg equations of motion by analogy with classical dynamics using the Poisson bracket formalism [see Abstr. 3348 (1951)]. The Schrödinger equation is investigated in co-ordinate representation, and it is shown that the wave function will have a non-integrable phase factor or quasi phase. The quasi phase leads to an indefiniteness in the wave function, but does not violate the fundamental laws of quantum mechanics nor lead to any ambiguity in the physical interpretation of the theory. The relation between the Schrödinger and the Heisenberg equations shows that the Schrödinger treatment is also consistent with the classical analogue. If there is a given initial probability that the non-holonomic system has co-ordinates $q_r^{(0)}$, then there will be the same probability that the wave function in the subsequent motion will be zero except in a certain region of co-ordinate space. This region is the part of co-ordinate space which is accessible in the classical theory from the point $q_r^{(0)}$. A.

530.145.6 : 537.533.74

3343. The relativistic theory of scattering in coulomb field by atoms. K. C. KAR, S. SENGUPTA AND P. P. CHATTERJI. *Indian J. Phys.*, **24**, 339–45 (*Aug.*, 1950).

Relativistic theory of nuclear scattering of electrons has been considered from the wave-statistical point of view. It has been shown that to a 1st-order relativistic approximation the ordinary hydrodynamical wave equation is slightly modified. On deriving the well-known χ-equations with the help of the modified equation we get a new term in the interaction energy which together with the other well-known interaction terms gives the correct scattering formula. A.

530.162

3344. The velocity Brownian movement. D. K. C. MACDONALD. *Phil. Mag.*, **42**, 219–20 (*Feb.*, 1951).

In a paper on the statistical analysis of electrical noise [see Abstr. 7753 (1950)] use was made of an example from the field of classical Brownian movement to clarify the concept of the observable velocity of a particle. In the present paper the author replies to a criticism of his treatment of this problem by R. Fürth [Abstr. 1628 (1951)]. T. C. TOYE

530.162

3345. A generalization of the method of Lennard–Jones and Devonshire for the calculation of the configurational integral. I. P. JANSSENS AND I. PRIGOGINE. *Physica*, **16**, 895–906 (*March*, 1951) *In French.*

A cell method for the evaluation of the configurational free energy is presented in which each cell can contain 0, 1 or 2 particles. This method gives a correct evaluation of the so-called "communal" entropy of the system. Numerical computations based on simple laws of force indicate that the value of the critical volume so calculated is in much better agreement with the experimental value than the value given by the Lennard–Jones and Devonshire method [*Proc. Roy. Soc. A*, **163**, 53 (1937); **165**, 1 (1938)]. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.221.3

3346. The characteristics of systems which are nearly in a state of neutral static stability. W. J. DUNCAN. *Quart. J. Mech. Appl. Math.*, **3**, 452–8 (*Dec.*, 1950).

It is shown that the rate of subsidence or divergence λ of a system which is near a state of neutral static stability can easily be calculated from a knowledge of the mode of displacement in the neutral state, and this mode is found by solving a set of linear algebraic equations. The first-order correction to the mode can also be found and in important cases this can be made the basis for calculating a second approx. to λ; if necessary, a further correction to the mode can now be found and from this a still more accurate root can be calculated. The method can be extended to continuous systems having infinitely many degrees of freedom. A.

531.224.8

3347. On the stresses in close-coiled helical springs. W. M. SHEPHERD. *Quart. J. Mech. Appl. Math.*, **3**, 459–68 (*Dec.*, 1950).

The stresses are analysed by considering the stresses in an incomplete circular ring. It is found that the cross-section of a ring made from originally circular wire is almost exactly circular, but that other shapes of cross-section would be very considerably modified. The stresses in a ring of circular section are obtained and good agreement is found with the results of

Göhner. Cross-sections of non-circular outline are considered with a view to reducing the maximum stress due to a given longitudinal force, but no worthwhile improvement on the circular form is found to be possible. A.

531.314.3

3348. The Hamiltonian dynamics of non-holonomic systems. R. J. Eden. *Proc. Roy. Soc. A*, **205**, 564–83 (*March* 7, 1951).

A formalism is developed which makes it possible to express the equations of motion of a non-holonomic system in Poisson bracket form. The main difficulty which has to be overcome arises from the fact that the Lagrangian co-ordinates and their corresponding momenta do not form a canonical set. However, at each instant of time, these variables can be expressed in a unique way as functions of a canonical set called the locally free co-ordinates and momenta. Poisson brackets can be formed with respect to the locally free variables, and it is shown that these lead to the correct equations of motion for a general dynamical system subject to a given set of non-holonomic constraints. Hamilton's principle applies to a non-holonomic system, so a principal function can be formed, and its properties are studied in the second part of this paper. In addition to the usual Hamilton–Jacobi equation, the principal function satisfies a set of equations corresponding to the set of constraints. It is shown that these equations imply an indefinite or non-integrable principal function. A non-integrable function is one for which the order of double differentiation is not reversible. A precise method is given for defining the principal function for a non-holonomic system, and it is shown how this leads to indefiniteness in its second derivatives. A.

531.391.1

3349. On the vibration and the impact of elastic cables. S. Kawashima. *Mem. Fac. Engng Kyushu Univ.*, **12** (*No.* 2) 60–138 (1950).

A detailed mathematical discussion of lateral and vertical vibrations of a cable hanging in an approximately parabolic curve. The frequencies of the different modes of transverse and longitudinal vibrations are compared. The effects of initial loads and of moving forces, which are of great practical importance in bridge suspension, etc., are considered. A calculation is made of the forces in the cable associated with elastic waves started by an impulse at one end, allowance being made for internal friction.

J. G. OLDROYD

531.51

3350. Gravitational radiation friction. D. D. Ivanenko and A. M. Brodskiĭ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 4) 519–22 (1950) *In Russian.*

Calculates on the basis of classical theory, the braking of a point particle by the radiation of gravity waves. F. LACHMAN

531.55

3351. A speed limit for rockets? W. Squire. *Indian J. Phys.*, **24**, 410 (*Sept.*, 1950).

The fallacies in Dixit's argument [Abstr. 2933 (1950)] that there is a fundamental speed limit to rockets are pointed out. A. C. CLARKE

531.578

3352. Velocities of steel fragments after perforation of steel plate. K. E. Spells. *Proc. Phys. Soc., Lond. B*, **64**, 212–18 (*March*, 1951).

531.66 : 539.8

3353. Impact flash at high speed water entry. J. H. McMillen, R. L. Kramer and D. E. Allmand. Letter in *J. Appl. Phys.*, **22**, 360–1 (*March*, 1951).

MECHANICAL MEASUREMENTS 531.7

531.765 : 621.317.39

3354. A ten-channel time discriminator. M. Surdin. *Trans Instrum. Meas. Conf., Stockholm* (1949) 289–90 (1950).

A form of chronoscope for the measurement of μsec to msec as required in radioactive measurements is described. Incoming pulses are amplified, gated and applied to 10 chopping circuits, then via anti-coincidence circuits to differential counting circuits. Each step is detailed briefly and some results on RaC emission are given. The method can also be applied to the measurement of the dead time of Geiger counters. E. H. W. BANNER (R)

531.787.6 : 545.827

3355. Diaphragm-type micromanometer for use on a mass spectrometer. V. H. Dibeler and F. Cordero. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 1–4 (*Jan.*, 1951).

A diaphragm-type micromanometer is described that is capable of measuring pressures in the range of 1 to 100 microns with a sensitivity of about 0·1 micron on the 50-micron scale. The displacement of the thin diaphragm is measured by the change in mutual inductance of two coils mounted above the centre of the diaphragm. The capsule is easy to assemble, and the rugged construction reduces the effects of mechanical vibration. The value of the manometer is illustrated by a comparison of the sensitivities of the isomeric heptanes, octanes and nonanes calculated from pressures measured in two ways. A.

531.787.6 : 545.827 : 621.317.79

3356. An electronic circuit for measuring the displacement of pressure-sensitive diaphragms. M. L. Greenough and W. E. Williams. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 5–10 (*Jan.*, 1951).

An instrument has been developed for indicating the position of thin pressure-sensitive diaphragms. As no appreciable load is placed on the diaphragm, the system is well adapted to the measurement of low absolute or differential pressures in the range from 0 to 100 μ. The electronic instrument gives full-scale indication for motions of $< 5\times10^{-4}$ in. Five tubes are incorporated in a circuit based upon the principle of the mutual-inductance micrometer for the detection of diaphragm motion. The same instrumentation may be utilized in other applications requiring the indication of very small displacements. A.

531.787.6 : 621.317.39

3357. Electronic micromanometer. *Radio Electronic Engng*, **16**, 7*A*, 31*A* (*Feb.*, 1951).

See preceding two abstracts.

MECHANICS OF FLUIDS 532

532.133

3358. The measurement of viscosity. II. Measuring apparatus. H. Umstätter. *Arch. tech. Messen, Issue No.* 179 (*Ref. V*9122–7) T136–T138 (*Dec.*, 1950) *In German.*

Continuation of Abstr. 1639 (1951). Details of design of 12 instruments, classified according to the type of viscosity variation to be studied. These include viscometers depending on the observation of flow between parallel plane surfaces in relative motion, flow between rotating cylinders, and flow in different types of capillary, Philipoff's apparatus for observing longitudinal oscillations of a needle in a capillary filled with liquid, Höppler's consistometer and Umstätter's double-cone consistometer for measuring viscosities of 10^3–10^{10} poises, and falling-body viscometers suitable for measurements at high pressures up to 1 200 atm. J. G. OLDROYD

532.137

3359. A coaxial-cylinder elastoviscometer. J. G. Oldroyd, D. J. Strawbridge and B. A. Toms. *Proc. Phys. Soc., Lond. B*, **64**, 44–57 (*Jan.*, 1951).

An instrument is described which was designed to measure the elastic and viscous properties of liquids, primarily of solutions of linear high polymers whose elastic properties had already been observed qualitatively. The liquid is contained in a narrow annulus between two long vertical cylinders. The outer cylinder can be driven in steady rotation at a known speed, or in harmonic angular oscillations of known amplitude and frequency. In steady rotation, the torque on the stationary inner cylinder is measured at different speeds, and interpreted to give a viscosity coefficient as a function of shear stress. In oscillatory motion, the amplitude of oscillation of the inner cylinder, when constrained by a torsion wire, is measured and plotted against the frequency. The shape of the resulting graph can be interpreted so as to distinguish and measure different types of elastic behaviour. The annular gap, the restoring constant of the torsion wire and the amplitude of oscillation of the outer cylinder can be varied in discrete steps. The angular velocity of the outer cylinder can be varied continuously from 0·3 to 3 000 rev/min in steady rotation, and the frequency can be varied continuously from 0·25 to 25 c/s in steady oscillation. The performance of the instrument in both steady-state and oscillatory experiments is assessed by comparing observed and predicted results for Newtonian liquids of known viscosity. An example is given of the behaviour of a typical polymer solution in both kinds of experiment, together with a suggested quantitative interpretation of the results. A.

532.51

3360. Cases of superposable fluid motions. A. N. Ergun. *Commun. Fac. Sci. Univ. d'Ankara*, **2**, 48–88 (1949).

The differential equations of fluid motion are not linear; their solutions are difficult and sometimes impossible; approximate methods of solution are therefore frequently used or unsound assumptions are made, e.g. in some cases it is assumed that two distinct solutions of the hydrodynamical equations of motion are linearly superposable, i.e. that their sum is also a solution. The author discusses critically this question of the possible superposability of solutions in four sections, viz. the first deals with motions u_1 superposable on a purely rotatory motion (U_2) with constant angular velocity, the second considers a more general type of motion (u_2) and the same motions U_1, the third discusses the same motions (U_1) but U_2 is constituted of a rotation about the z axis together with a parallel flow along that axis; these are not superposable; in the fourth U_1 is a two-dimensional radial motion while U_2 is a radial flow plus an axial motion, steady and unsteady flow being discussed. J. S. G. THOMAS

532.51

3361. Hydrodynamics. G. Birkhoff. *Princeton University Press; London, Geoffrey Cumberlege* (1950) 186 *pp.*

The first chapter of this book is devoted to "hydrodynamical paradoxes," i.e. to the description of the solutions of problems which, either through unjustifiable approximations or incorrect formulations of the physical situation, are found to disagree with experiment. The second chapter is devoted to recent progress in free boundary theory with many illustrative examples. The last three chapters are concerned with modelling and dimensional analysis, use being made of the notion of symmetry, and to the applications of group theory to hydrodynamics. The illustrations are drawn both from the fluid mechanics of incompressible flow and from gas-dynamics. There are three plates and 20 illustrative figures in the text. G. C. McVittie

532.51 : 551.513

3362. Contribution to the solution of the equations of motion of a fluid and of the equations of general atmospheric circulation. E. Lahaye. *Inst. Roy. Met. Belg. Mem.*, **38**, 78 *pp.* (1950) *In French.*

Conditions under which the equations of motion of a fluid moving over a closed surface can be integrated are studied. Steady and non-steady states are discussed. The first part of the paper restricts the study to the steady motion of a perfect incompressible fluid. A new type of solution, which defines the velocity components (u, v, w) in terms of the components of vorticity (ξ, η, ζ), is derived. Introduction of the boundary conditions at the closed surface necessitate that the vorticity components (ξ, η, ζ) are respectively proportional to the velocity components (u, v, w). A method of integration involving successive convergent approximations applicable throughout the domain in which the functions concerned are regular is derived. The consideration of the motion of a fluid subject to adiabatic compression leads to similar results. The steady motion of an incompressible viscous fluid can be solved in the same manner. In the second section, non-steady motion is discussed, Navier's equations being employed. In the case of the non-steady motion of a compressible fluid, subject to adiabatic compression, such motion is incompatible with arbitrary boundary conditions at the

closed surface; waves of discontinuity are propagated in the fluid. A mean motion of the fluid about which state the fluid particles oscillate when affected by such a discontinuity is therefore introduced into the discussion, and it is shown how, by the introduction of a variable-interval parameter, τ, and certain suitably chosen arbitrary functions, the equations of motion can be integrated. The method of solution is illustrated by solution of the equations for a finite number of values of τ. A particular solution of the equations of non-steady motion of an incompressible viscous fluid is derived. The third section discusses, very briefly, motion of a fluid relative to that of a surface rotating uniformly about an axis, e.g. the motion of the atmosphere relative to the earth.

J. S. G. THOMAS

532.516

3363. Hydrodynamic lubrication: general survey. D. G. CHRISTOPHERSON. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 1–7 (1951).

The assumptions underlying lubrication theory are examined critically. Attention is drawn to the importance in practice of the variation of viscosity with temperature and with pressure, the surface roughness of the metal parts, and the ways in which deformation of a bearing can arise. The hydrodynamic forces in a lubricating film may be sufficient to cause smoothing of surface roughnesses, e.g. by plastic deformation, without the occurrence of any metal-to-metal contact.

J. G. OLDROYD

532.516

3364. Temporary reduction of viscosity of liquids at high rates of shear. W. J. MORRIS AND R. SCHNURMAN. Letter in *Nature, Lond.*, **167**, 317 (*Feb.* 24, 1951).

532.517 : 541.182

3365. The flow properties of elastic dispersions. W. J. DUNNING AND D. PATTERSON. *Trans Faraday Soc.*, **46**, 1095–101 (*Dec.*, 1950).

The flow properties of dispersions of latex rubber in Aroclor 4465 (a "liquid" with a viscosity of about 10^{10} poises) have been studied. The form of the compression-time curves and the order of magnitude of the strain relaxation time agree with the theory of Fröhlich and Sack. A.

532.52

3366. Some recent investigations in the theory of hydrodynamic stability. J. R. FOOTE AND C. C. LIN. *Quart. Appl. Math.*, **8**, 265–80 (*Oct.*, 1950).

Previous investigations [Abstr. 1239, 1240, 1241 (1946)] are extended to cases where no solid boundary is present, with particular applications to the stability of two-dimensional wakes and jets and of zonal winds in the atmosphere. It is shown that, in all these cases, a necessary and sufficient condition for the existence of (non-trivial) neutral or self-excited disturbances is the occurrence of a maximum or a minimum in the vorticity. J. G. OLDROYD

532.52 : 536.25

3367. Observation of initial flow in a fluid obeying Darcy's law by radioactive-tracer techniques. F. T. ROGERS, JR. AND L. E. SCHILBERG. Letter in *J. Appl. Phys.*, **22**, 233–4 (*Feb.*, 1951). See Abstr. 1539 (1950).

532.525 : 532.595

3368. The theory of waves travelling on the core in a swirling liquid. A. M. BINNIE. *Proc. Roy. Soc. A*, **205**, 530–40 (*March* 7, 1951).

An examination is made of waves moving under centrifugal force and surface tension along the core in a swirling liquid. The waves may be of varicose form in which the cross-section of the core remains circular, or they may be helical, giving the core the shape of a multi-threaded screw. The relation is obtained between the lengths of the waves and their axial and angular velocities; at a critical length the waves possess a minimum velocity. The group velocities are determined, and are shown to be negative under certain conditions. It is found that waves can exist which move so slowly that they should be readily visible although the core may be revolving at high speed. A.

532.526

3369. The boundary layer in three dimensional flow. I. Derivation of the equations for flow along a general curved surface. L. HOWARTH. *Phil. Mag.*, **42**, 239–43 (*March*, 1951).

The general equations of boundary layer flow along a curved surface S are set up in an appropriate system of orthogonal co-ordinates and the importance of the curvatures in the general case is made evident. It is shown that, for a general flow, the necessary and sufficient condition for the curvatures to disappear from the equations of flow is that the boundary layer should be along the surface of a cylinder or a plane. The form assumed by the equations when S is a surface of revolution is derived. A.

532.58

3370. The movement of a cohesionless granular bed by fluid flow over it. R. A. BAGNOLD. *Brit. J. Appl. Phys.*, **2**, 29–34 (*Feb.*, 1951).

Our knowledge of the basic principles underlying "Loose boundary hydraulics" is weak, owing mainly to the difficulties of observation and measurement. The corresponding case of grains moved by wind presents fewer experimental difficulties and is found to be fairly simple. But the behaviour of the grains is here so different that the principles have not been found easy to apply to the water case. These differences are examined, and an attempt is made to explain them in terms of the relative degree to which a free grain can penetrate through the fluid under its own initial momentum. The penetration is defined, and its effects are applied to various grain-fluid phenomena. A.

532.58

3371. A study of motions in a rotating liquid. G. W. MORGAN. *Proc. Roy. Soc. A*, **206**, 108–30 (*March* 22, 1950).

Starting with the equations of motion for a perfect, incompressible fluid referred to a co-ordinate system which rotates about a vertical axis with uniform angular velocity R, the physical condition of "small motion" is determined which permits the equations to be linearized. The small motions resulting from forced oscillations of a rotating liquid are investigated. It is shown that there are 3 types of flow depending on the relative magnitudes of the impressed

frequency β and the angular velocity R of the fluid. Two of the regimes are studied in detail. A similarity law is developed which gives the solution of a class of problems of oscillations for $\beta > 2R$ in terms of the solutions to similar irrotational problems. An attempt is made to explain how slow, two-dimensional motion can be produced by introducing a boundary condition which is 3-dimensional (as observed in experiments performed by G. I. Taylor), by considering problems from the moment at which the disturbance is created from rest relative to the rotating system, with the only initial assumption that the fluid is rotating uniformly like a solid body. A.

532.581

3372. A correlating modulus for fluid resistance in accelerated motion. H. W. IVERSEN AND R. BALENT. *J. Appl. Phys.*, **22**, 324–8 (*March*, 1951).

The resistance to accelerating movement of objects in a fluid is normally evaluated with a mass term in the equation of motion that is greater than the actual mass of the object by an added mass described as a constant times the displaced mass of fluid. A few previous experiments on resistance in unidirectional accelerated motion indicate that the added mass is variable and depends upon the state of motion. The present investigation includes a development from model law considerations that results in a resistance equation of the form $F = C\frac{1}{2}\rho V^2 S$. This is identical with the normal resistance equation for steady state except for the coefficient C which, in addition to being a function of Reynolds' modulus, Froude's modulus, and the geometry, is also a function of a modulus, AL/V^2, where A is the acceleration, L is a characteristic length, and V is the velocity. A.

532.59

3373. Reflection of water waves from floating ice in water of finite depth. M. WEITZ AND J. B. KELLER. *Commun. Pure Appl. Math.*, **3**, 305–18 (*Sept.*, 1950).

The problem is formulated analytically in terms of an integral-equation, which is a modification of the Wiener–Hopf type. This equation is solved by an extension of Heins's method [*Amer. J. Math.*, **70**, 730–48 (1948)]. Reflection and transmission coefficients are calculated. L. S. GODDARD

532.592

3374. Forces exerted by waves on a sloping board. W. S. HAMILTON. *Trans Amer. Geophys. Un.*, **31**, 849–55 (*Dec.*, 1950).

A piece of plywood was mounted on six strain-gauge cells in a wave tank to determine wave forces on a mildly sloping plane. Wave heights upwind and downwind were measured to find its effectiveness as a stilling device. The measurements showed that the reactions of the supports did not exceed those that would be produced by a uniform hydrostatic loading equal to 0·8 of the wave height applied alternately upward and downward. A properly placed board reduced wave heights downwind to $< 60\%$ of the height upwind provided their length was not more than $4\times$ the board width measured parallel to the direction of wave propagation. Waves about as long as the board width were reduced as much as 90%. A method of estimating wave loading is suggested. A.

532.592

3375. A note on the tangential transfer of energy between wind and waves. S. A. SCHAAF AND F. M. SAUER. *Trans Amer. Geophys. Un.*, **31**, 867–9 (*Dec.*, 1950).

532.593

3376. On surface waves. A. WEINSTEIN. *Canad. J. Math.*, **1** (*No.* 3) 271–8 (1949).

Various mathematical aspects of the linearized theory of surface waves are discussed, including the 3 methods now available: (1) the eigenvalue method, (2) the method of reduction, (3) the method of singular integral equations. It is shown that (2) and (3) may be combined to give more complete results than obtained previously. As an illustration the problem of waves in an ocean of infinite depth is considered. The ocean is bounded on one side by a vertical cliff, and the wave crests are not assumed to be parallel to the shore line. L. S. GODDARD

532.593

3377. The wave motion of the sea at a beach. M. ROSEAU. *C.R. Acad. Sci., Paris*, **232**, 211–13 (*Jan.* 15, 1951) *In French.*

Continuation of Abstr. 1647 (1951). The general solution is obtained assuming for the potential Φ the form $\Phi = e^{i\sigma t}\phi(x, y,)$. J. E. CAFFYN

532.593

3378. The wave motion of the sea at a beach. M. ROSEAU. *C.R. Acad. Sci., Paris*, **232**, 303–6 (*Jan.* 22, 1951) *In French.*

Continuation of Abstr. 3377 (1951). The complex potential associated with wave motion up a beach inclined at 45° to the horizontal is calculated.

J. G. OLDROYD

532.593 : 551.465

3379. The application of conformal transformations to ocean wave refraction problems. L. S. POCINKI. *Trans Amer. Geophys. Un.*, **31**, 856–66 (*Dec.*, 1951).

If the bottom contours are considered straight and parallel, and if the usual assumptions are made, a simple differential equation for the orthogonals can be derived from Snell's Law. Solutions to the equation are easily obtained. Conformal transformations may be applied to change the contours in the complex Z-plane into several different configurations in a complex W-plane. In each case an orthogonal in the Z-plane maps into a new orthogonal in the W-plane, and thus a solution to the problem of wave refraction over the contour system in the W-plane is obtained. An expression for K_d is then derived from the orthogonal pattern. Cases treated include a circular island, a reef and a bay with parabolic contours, and twin islands. The method indicates considerable future possibilities in different applications.

A.

CAPILLARITY 532.6

532.64

3380. The spreading of liquids on low energy surfaces. I. Polytetrafluoroethylene. H. W. FOX AND W. A. ZISMAN. *J. Coll. Sci.*, **5**, 514–31 (*Dec.*, 1950).

Methods of preparing surfaces of polytetrafluoroethylene (TFE) are described which permit

obtaining reproducible and reliable measurements of contact angles with liquids. Polytetrafluoroethylene is found to be an ideal low energy surface for the study of the wetting relations of a solid with a wide variety of organic and inorganic liquids. It is concluded that the corrected Young–Dupré relation coupled with the spreading coefficient permits a rational description of the results. The Doss and Rao relation for the surface condensation leads to such high values for high-boiling liquids as to make it unlikely that the theory is correct. A.

532.96

3381. Hysteresis of wetting and stability of drops or air bubbles on a solid surface. H.-L. Rosano. *C.R. Acad. Sci., Paris*, **232**, 488–90 (*Feb.* 5, 1951) *In French.*

The least force required to displace a water drop on a horizontal plate (or an air bubble under an immersed plate) is $\Phi\Delta\tau$, where Φ is the diameter measured perpendicular to the direction of displacement and $\Delta\tau$ is the hysteresis of wetting. $\Delta\tau$ was measured by noting the angle of tilt of the plate at which the drop or bubble became unstable and compared with values given directly by the method of Guastalla [*C.R. Acad. Sci., Paris*, **226**, 2054 (1948)]. W. C. A. HUTCHINSON

532.69 : 551.578.1

3382. The behavior of water drops at terminal velocity in air. D. C. Blanchard. *Trans Amer. Geophys. Un.*, **31**, 836–42 (*Dec.*, 1950).

An insight into the behaviour of large raindrops has been obtained by studying drops of water freely suspended in a vertical air stream. The wind tunnel employed is described. The stroboscopic pictures taken of the waterdrops show that extreme periodic deformations occur on drops of > 5 mm dia. The behaviour of drops before and after collision was observed. Drops which come into a region within 6 cm above another drop usually begin to fall in an ever-tightening spiral until collision takes place. The bombardment of large drops with a spray of small droplets showed that not all the small droplets coalesced with the large drops. Some of the smaller droplets would roll across the under surface of the large drop exhibiting a "bounce-off" effect. The break-up of a large waterdrop is easily brought about by imparting a sudden upward acceleration to the air through which it falls. On the other hand, a downward acceleration of the air is relatively ineffectual in causing break-up. The influence of the periodic deformation in causing break-up can be demonstrated by actually pumping air into a drop until the air bubble constitutes as much as 30% of the drop. Such air-bubble drops show little or no deformation and will thus remain intact even when subjected to extremely turbulent air. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

3383. Theory of structure of water. A. Gierer and K. Wirtz. *Z. Naturforsch.*, **5a**, 577–80 (*Nov.*, 1950) *In German.*

An attempt at reconciling Eucken's theory of polymorphous aggregates with the theory of the quasi-crystallinity of liquid water of Bernal–Fowler. F. LACHMAN

532.7

3384. Recent theories of transport processes in liquids. R. Eisenschitz. *Nature, Lond.*, **167**, 216–20 (*Feb.* 10, 1951).

A review of the work done in recent years on the kinetic theory of liquids with particular reference to the explanation of irreversible processes such as viscous flow or heat conduction, the progress made towards a general theory of irreversible processes being considered. A comprehensive list of references is given. T. C. TOYE

532.72

3385. Research on thermodiffusion in the liquid phase. II. I. Prigogine, L. de Brouckère and R. Amand. *Physica*, **16**, 851–60 (*Dec.*, 1950) *In French.*

For Part I see Abstr. 120 (1951). The authors have studied the thermal diffusion of associated solutions by the thermogravitational method. Experiments have been carried out with methanol–benzene, ethanol–cyclohexane, cyclohexanol–cyclohexane and ethanol–dioxane. The Soret coefficient D'/D was found to vary considerably with concentration, contrary to what had been observed with perfect solutions. In an inert solvent, such as benzene or cyclohexane, the sign of D'/D was reversed when passing from low to high concentrations: the alcohol accumulated in the bottom reservoir when its concentration was weak, in the top reservoir when its concentration was strong (this was not due to the "forgotten" effect). There seems to be a close relation between this sign reversal of D'/D and the association itself. The interaction between a molecule of alcohol and a neighbouring molecule of solvent was, in all cases examined, greater than between two molecules of solvent. The reversal observed with inert solvents was related to an entropy increase due to destruction of complexes which took place when a molecule of alcohol and a molecule of inert solvent exchanged their position. A.

532.782

3386. Function of the freezing nuclei in supercooled water. W. Rau. *Z. Naturforsch.*, **5a**, 667–75 (*Dec.*, 1950) *In German.*

By means of spectrum determinations of supercooled water at a temperature region around $-20°$, two freezing maxima at $-4°$C and $-12°$C have been established. Addition of powdered substances such as room dust, firedust, chalk, quartz, gypsum, etc., develops the former maximum at the expense of the latter, and while the structures of these introduced nuclei have no particular influence, it is necessary that they should be dry. The interpretation of the freezing process proposed is that the crystallization is released by penetration of the dry freezing nuclei into the water with development of an electrical double layer. The maxima of $-12°$ observed by Peppler [*Z. angew. Met.*, **56**, 173 (1939), and *Forschg. ErfahrBer. Reichswettdst, B*, N1 (1940)] and of $-4°$ by Schwerdtfeger [*Meteor. Rundschau*, **1**, 453 (1948)] thus receive explanation. 16 references. H. H. HODGSON

532.785 : 539.16

3387. The crystallization of solutions of potassium and of strontium nitrate followed by means of radio-strontium as indicator. J. PAULI AND P. SÜE. *C.R. Acad. Sci., Paris*, **231**, 1479–80 (*Dec.* 18, 1950) *In French.*

Active Sr* of period 55 days and emitting β^- rays, has been used to determine the inclusion of Sr during the crystallization of aqueous solutions containing both KNO_3 and $Sr(NO_3)_2$. With ratios of Sr/K varying from 10^{-1} to 10^{-6}, the inclusion of Sr is identical whether crystallization is carried out rapidly or gradually for micro- or macro-crystals respectively.

H. H. HODGSON

MECHANICS OF GASES 533

533.1

3388. Laboratory apparatus for flow experiments. I. Adjustment of constant gas flow by critical orifices. R. VESTIN, O. OLSSON AND A. SOMERSALO. *Trans Instrum. Meas. Conf., Stockholm* (1949) 297–303 (1950).

Theoretical considerations lead to practical constructions of apparatus for measurement of pressure and flow in glass tubes. Methods of calibration are given.

E. H. W. BANNER

533.1

3389. Laboratory apparatus for flow experiments. II. Precision device for continuous slow-speed feeding and evaporation of volatile liquids. R. VESTIN AND O. OLSSON. *Trans Instrum. Meas. Conf., Stockholm* (1949) 304–7 (1950).

The theoretical and practical construction of apparatus for a flow range of 10–200 mm^3/min is detailed. Errors due to temperature changes are examined and precautions given, with methods of checking. Typical results are quoted.

E. H. W. BANNER

533.15

3390. Contribution to the classical diffusion theory. G. BIEGELMEIER. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 278–89 (1950) *In German.*

A mathematical solution is given of a diffusion problem in which, at $t = 0$, the concentration within a cube enveloping the origin of co-ordinates is $= 0$, while the concentration in the surrounding space is invariably $= c_0$, or vice versa. The solutions obtained are the transcendental functions of Gauss's probability integral.

F. LACHMAN

533.16 : 533.7

3391. The viscosities of organic vapours. P. M. CRAVEN AND J. D. LAMBERT. *Proc. Roy. Soc. A*, **205**, 439–49 (*Feb.* 22, 1951).

The viscosities of the vapours of ethane, *n*-hexane, cyclohexane, benzene, methyl chloride, ethyl chloride, methyl alcohol, diethyl ether, acetaldehyde, acetone and acetonitrile have been measured at temperatures 35, 50, 65 and 78°c and pressures between 1 and 3 cm. Measurements were made by observing the damping of a pendulum swinging in the vapour. A linear relation between coefficient of viscosity and temperature was found in all cases. The ratios of thermal conductivity to viscosity were calculated, using thermal conductivity values obtained recently in the same temperature range. The observed values of the Eucken factor for non-polar vapours show systematic positive deviations from the theoretical values; strongly polar vapours show systematic negative deviations; weakly polar vapours show intermediate behaviour. The theoretical implications of these phenomena are discussed.

A.

533.17 : 537.534

3392. Gas flow through the mass spectrometer viscous leak. R. E. HALSTED AND O. NIER. *Rev. Sci. Instrum.*, **21**, 1019–21 (*Dec.*, 1950).

An approximate expression for the flow of a binary gas mixture through a mass spectrometer "viscous" leak has been derived and compared with experimental data. The factors important in the design and use of the leak are determined from this result.

A.

533.5

3393. An ionization pump. R. CHAMPEIX. *Vide*, **5**, 912–13 (*Nov.*, 1950) *In French.*

Describes an experimental arrangement in which the fore-vacuum pressure of 1 mm Hg is lowered by a factor of about 10^4, about 1 000 volts being used to sweep ionized gas from the high vacuum to the fore-vacuum side of the pump.

L. G. CARPENTER

533.5 : 537.547 : 621.385

The physical basis of the residual vacuum characteristic of a thermionic valve. *See Abstr.* 3596

533.5 : 621.317.39

3394. The measurement of high vacuum by electrical methods. II. F. WADE. *Electronic Engng*, **23**, 44–8 (*Feb.*, 1951).

See Abstr. 2439 (1951). The Penning, the triode ionization, the alphatron and the Knudsen gauges are described and their theories are briefly dealt with. The ionization gauge with negative grid and positive anode may be treated mathematically with sufficient accuracy but this is not the case with the more sensitive connection in which the grid is positive and the anode negative, as with this it is difficult to estimate the number of times that the electron oscillates about the grid. The various types of gauges are critically compared and a chart shows their optimum ranges. Circuits are shown for the combinations of a Pirani and an ionization gauge and of a thermocouple and a Penning gauge.

R. NEUMANN

533.6.01

3395. On a paradox noted by Mr. Garrett Birkhoff. D. RIABOUCHINSKI. *C.R. Acad. Sci., Paris*, **231**, 1269–71 (*Dec.* 6, 1950) *In French.*

G. Birkhoff [*Hydrodynamics*, Princeton (1950)] has pointed out that two characteristic equations are used in the theory of propagation of sound waves of finite amplitude through a compressible fluid; in one case the pressure $\propto$ (density)$^{-1}$ and in the other $\propto$ (density)^2. This apparent inconsistency is explicable, in the opinion of the author, by the fact that the former equation represents only an approx. to the true flow of a fluid, in which the flow is treated as almost isentropic. This approx. treatment breaks down when energy is dissipated at some point in

the flow field, e.g. in a shock-wave. A study of the difference between the approx. solution and the true flow then serves to locate and define the energy dissipation. A. SCHOFIELD

533.6.01 : 532.51 : 621.317.729

3396. Three-dimensional potential gradient tank. L. A. STENSTRÖM. *Trans Instrum. Meas. Conf., Stockholm* (1949) 281–5 (1950).

A tank is described for measurements on the velocity distribution around 3-dimensional aircraft and ship models. The analogy between Laplace's equations and the experimental electrical case is shown to be correct, and if the model is of insulating material and small in relation to the tank, high accuracy is attainable. A.C. of 25 V, 433 c/s is used, with glass probes and an amplifier feeding a c.r.o. Practical notes are given, with some results.

E. H. W. BANNER (R)

533.6.011

3397. The velocity distribution round a symmetrical profile on the basis of local supersonic regions. K. OSWATITSCH. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 228–71 (1950) *In German.*

Velocities in the sonic region are first considered briefly on the basis of the Prandtl, Mach and Rayleigh–Jantzen methods. Integral equations are derived from the Cauchy–Riemann differential equations and used to determine the velocity distribution for supersonic conditions. The results are shown graphically for several profiles and there is good agreement with experimental results. Finally an approximate method is given and the calculation of wing resistance is indicated. E. H. DOCK

533.6.011

3398. Determination of axially-symmetric flow patterns of a compressible fluid. S. BERGMAN. *J. Math. Phys.*, **29,** 133–45 (*Oct.*, 1950).

The potential function of an axially-symmetric flow of compressible fluid satisfies a non-linear partial differential equation. The method of infinite approximation by a system of linear equations is applied to the solution of the equation of axial symmetric flow. In the two-dimensional case, considered in the hodograph plane, the functions satisfy a linear equation, for which flow patterns have been found. The solution $\phi^{(0)}$ for plane flow is used as a first approximation for the function ϕ connected simply with the first-mentioned potential function. A non-linear equation is then obtained for $\phi - \phi^{(0)}$. The method of successive approximations is then applied to replace this equation for $\phi - \phi^{(0)}$ by a sequence of linear non-homogeneous equations $L_n(\phi^{(n)}) = 0$. Procedures are developed for solving these equations for small values of $n = 1, 2$, which are suitable for practical purposes. Analytic solutions of the equation for $\phi - \phi^{(0)}$ alone are discussed in the complex domain, so that sub- and super-sonic regions can be considered together, and solutions obtained for the mixed case. J. S. G. THOMAS

533.6.011

3399. A new form of solution of Hermite's equation. W. A. MERSMAN. *J. Math. Phys.*, **29,** 191–7 (*Oct.*, 1950).

A modification of Hermite's differential equation occurs in the work of Chapman and Rubesin on the laminar boundary layer of a compressible fluid flowing over a heated flat plate [*J. Aero. Sci.*, **16,** 564 (*Sept.*, 1949)]. The equation is $d^2u/dz^2 + 2zdu/dz - 4nu = 0$ ($n = 0, 1, 2, 3 \ldots$), in which u is a dimensionless coefficient occurring in a series expansion for the temperature, and z is a distorted dimensionless co-ordinate representing distance normal to the plate, the surface of which is approximately at $z = 0$, and the free stream outside the boundary layer is at $z = \infty$. A solution is derived in the form $u(z) = AH_{2n}(iz) + BF_n(z)$ where $F_n(z) =$

$$(-1)^n n!/(2n)![H_{2n}(iz)(2/(\pi)^{\frac{1}{2}})\int_z^\infty e^{-t^2}dt - (2/\pi^{\frac{1}{2}})K_{2n}(z)e^{-z^2}]$$

The primary purpose of the paper is to obtain a solution of the equation which is tractable to numerical computation. The method of solution is applicable to any linear, homogeneous differential equation of the 2nd order to obtain a 2nd solution when one is known, and is applicable to the solution of Hermite, Laguerre, Bessel and Legendre equations. J. S. G. THOMAS

533.6.011.4

3400. The "tip effect" in oscillating supersonic flow. G. TEMPLE. *Ric. Sci.*, **20,** 1938–9 (*Dec.*, 1950).

Developments in the theory of oscillating supersonic flow, and more especially, a simplification of Miles's theory of "tip effect" in aeroplane rectangular wings are discussed, by application of Fourier transforms of the reduced velocity potential and of the Wiener–Hopf technique. An expression for the tip correction to the spanwise pressure integral is derived in the form of an integral involving the known downwash, and this can be easily generalized to account for pitching motion. J. S. G. THOMAS

533.6.011.5

3401. The conditions at a sharp leading edge in supersonic flow. O. BARDSLEY. *Phil. Mag.*, **42,** 255–62 (*March*, 1951).

Schlieren photographs have been taken to show the supersonic flow past a sharp wedge placed at an incidence large enough to give an expansion region on one side. In addition to the flow phenomena predicted by inviscid theory, the photographs show a weak shock wave immediately upstream of the expansion region. Various possible explanations of this are considered and it is shown that the shock wave is caused by the slight bluntness of the leading edge, although the thickness of the leading edge is only about 8 μ. It cannot be explained by considering the growth of the boundary layer, neither is there any evidence of boundary-layer separation. A.

MOLECULAR THEORY OF GASES . 533.7

533.7

3402. The absorption of interrupted infra-red radiation. T. L. COTTRELL. *Trans Faraday Soc.*, **46,** 1025–30 (*Dec.*, 1950).

It is shown that the rate of increase of translational energy in a gas illuminated by interrupted i.r. radiation is a function of the frequency of interruption,

and it is suggested that in principle this provides a method of investigating the time constants involved in the interconversion of translational and vibrational energy. A.

533.75

3403. Determination of the second virial coefficient and the van der Waals' force of methane. E. KANDA. *Sci. Rep. Res. Inst. Tohuku. Univ., Ser. A.*, **1**, 157–60 (*Oct.*, 1949).

VIBRATIONS . ACOUSTICS 534

534.01

3404. On amplitude bounds for certain relaxation oscillations. N. WAX. *J. Appl. Phys.*, **22**, 278–81 (*March*, 1951).

Amplitude bounds are obtained for the unique periodic solution of the generalized Lienard equation $x + f(x)x + g(x) = 0$, when the functions $f(x)$ and $g(x)$ are restricted suitably. The restrictions are less severe for the lower than for the upper bounds. A class of equations is exhibited which includes the van der Pol equation and satisfies all the restrictions. Numerical results are given for the van der Pol equation. A.

534.1

3405. Free oscillations and discharge oscillations. M. R. FORTRAT. *J. Phys. Radium*, **12**, 41–50 (*Jan.*, 1951) *In French.*

Criticizes van der Pol's work in *Onde Elect.*, **9** (1930). Discusses the harmonic equation $Ax'' + Bx' + Cx = 0$. Proceeds to more complicated equations for non-sinusoidal oscillations, in rotors and dynamos, as $Li'' - v'i + i/C = 0$, and furnishes the curve by graphical integration. Gives equations for the discharge of condenser and neon tube: for a dynatron: for a mechanical switch formed of a weight to be overbalanced by a vessel filled with water, which then empties itself. Other equations deal with siphons and periodic whirls detaching themselves from lighted candles, and vibrations of a string rubbed by a bow. A. B. EASON

534.131 : 539.384 : 548.0

3406. Thickness-shear and flexural vibrations of crystal plates. R. D. MINDLIN. *J. Appl. Phys.*, **22**, 316–23 (*March*, 1951).

The theory of flexural motions of elastic plates, including the effects of rotary inertia and shear, is extended to crystal plates. The equations are solved approximately for the case of rectangular plates excited by thickness-shear deformation parallel to one edge. Results of computations of resonant frequencies of rectangular, *AT*-cut, quartz plates are shown and compared with experimental data. Simple algebraic formulae are obtained relating frequency, dimensions, and crystal properties for resonances of special interest in design. A.

534.133 : 535.417

3407. Interferometric studies on the vibration of piezoelectric plates. S. TOLANSKY AND W. BARDSLEY. *Proc. Phys. Soc., Lond. B*, **64**, 224–30 (*March*, 1951).

A description is given of the application of a number of multiple-beam interference methods to the study of the piezoelectric oscillations of some quartz crystals. The distribution of surface nodes and antinodes of motion and the amplitudes of oscillation are revealed by simple methods. By employing a stroboscopic illumination technique the phase relations between the various vibrating regions of the crystal surface are revealed. The nodal regions are shown to be at rest to within < 50 Å and the surface deformations are revealed to at least a similar order of accuracy. By a modified technique fringes are obtained through the crystal body and these reveal changes in the optical thickness. One crystal developed sharp surface discontinuities after being set into oscillation, indicating that crystallographic glide or slip had taken place. This is shown to be closely related to the familiar shattering of quartz crystals at excessive amplitudes of oscillation. A.

534.15 : 621.395.623

3408. Three-transducer reciprocity formula for vibration pick-ups. S. GREENBLATT. Letter in *J. Acoust. Soc. Amer.*, **22**, 881 (*Nov.*, 1950).

Reference is made to (1) an early paper [Abstr. 3120 (1948)] on reciprocity calibration, where relationships are derived for a procedure using two pick-ups and a vibrator, and (2) a subsequent paper [Abstr. 121 (1949)], where an alternative method using three pick-ups is indicated. Based on these papers a formula for the sensitivity of any one of these three pick-ups is derived. Each pick-up in turn is used to drive one of the other two and the input driving current and output voltage are read. In each case the voltage value can be expressed in terms of the current, the blocked force per unit driving current, and the impedances involved. The six expressions can be combined to give a formula in which the sensitivity of any one pick-up is expressed in terms of the six voltage and six current values.

H. G. M. SPRATT (R)

534.21 : 551.596.1

On the propagation of sound over great distances. *See Abstr.* 4007

534.22.093.3

3409. Ultrasonic velocities in organic solutions. K. C. LAL. *Indian J. Phys.*, **24**, 461–5 (*Oct.*, 1950).

Measurements on ultrasonic velocities and compressibilities of solutions of different concentrations of benzoic acid in toluene and xylene at various temperatures are reported. It has been found that velocity increases with dilution and the adiabatic compressibility increases with concentration. The ultrasonic velocity in solutions decreases with the increase in temperature. A.

534.23 : 541.6

3410. The effect of ultrasonic vibrations on the polymorphic transformation of ammonium nitrate. A. P. KAPUSTIN. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 3) 393–4 (1951) *In Russian.*

Using a method described previously [Abstr. 5638 (1950)] and using a quartz plate 2 mm thick and 30 mm dia. as the ultrasonic emitter, the polymorphic transformations of ammonium nitrate at 125, 84 and 32° C were studied. For low intensities (up to

1 W/cm³) the 3 transformations were identical with those observed in the absence of the vibrations. For large intensities, however, it was possible to adjust conditions so that the boundary between the initial and new phases, at the moment of applying the vibrations, stops, and begins to be displaced in the opposite direction to its original direction. Switching off the vibrations causes the slow boundary movement to continue in its original direction. Successive application and removal of the sonic field can therefore be used for moving the boundary to and fro. The most interesting phenomenon was observed at a certain definite value of the field intensity, when the front of the polymorphic transformation, distributed in the solid phase, stopped instantly on application of the field and remained thus for 2–3 minutes. When the phenomenon was further observed the phase boundary moved again after this time interval in the normal direction of the transformation. These effects were observed at 125 and 84°c but not at 32°c. These experiments show that the effect of ultrasonic vibrations on phase transformation is apparent not only in the case of crystallization but also in polymorphic transformations. They also indicate that there will be an effect on the distribution of elastic stresses in the solid body.

W. HUGHES

534.231.3

3411. A demonstration of specific acoustic resistance. J. S. RINEHART. *Amer. J. Phys.*, **18,** 546–8 (*Dec.*, 1950).

534.232 : 621.3.012.8 : 621.395.623.7

3412. The acoustic coupling between the diaphragms of two coaxial loudspeaker units. G. B. MADELLA. *Alta Frequenza*, **19,** 267–76 (*Oct.–Dec.*, 1950) *In Italian.*

An equivalent circuit is derived for a pair of loudspeakers and it is shown that the acoustic coupling between them may have a considerable effect on their combined performance. Curves given show typical values of the various parameters.

V. G. WELSBY (R)

534.232 : 621.314.2

3413. Electroacoustic transformation caused by magnetostriction with special consideration of the radiation from practical transformers. H. H. RUST. *Z. angew. Phys.*, **2** (*No.* 12) 487–91 (1950) *In German.*

The production of non-sinusoidal mechanical vibrations by magnetostriction is explained with the aid of strain/polarization curves for Ni, Fe, and Si–Fe rods. The influence of steady polarization and hysteresis on the output for sinusoidal excitation is pointed out and the Fourier components of the resulting waveform tabulated. The use of iron is shown to lead to oscillations which are relatively richer in higher harmonics. This is explained by the occurrence of the Villari point for ferrous materials (resulting in the reversal of the direction of strain at a certain value of field). This point is shifted into the high-H region for increasing Si content and 7% Si alloy exhibits no magnetostriction at all. These harmonic effects are not normally encountered since resonant structures are usually employed. They can occur, however, in the case of ordinary transformers and it is shown that where these are immersed in insulating oil the well-known effects of supersonics on fluids can lead to deterioration of performance. A possible effect, for example, is the release of adsorbed gases leading to cavitation which may initiate gas discharges in bubbles owing to the greatly altered voltage distribution in the dielectric. Two methods are considered for avoiding this trouble. The first is the use of high-Si alloys which, however, are difficult to roll thinly because of their brittleness. The second is the use of cellular sound-reflecting material close to the core though this is also open to objection since it restricts heat radiation. The occurrence of similar effects in oil-filled cables carrying a.c. is also mentioned.

S. C. DUNN (R)

534.32 : 612.85

3414. Frequency differential thresholds for quality in pure tones. P. DENES AND F. A. CARTIER. Letter in *Nature, Lond.*, **167,** 204 (*Feb.* 3, 1951).

The authors state that it is not only possible to observe quality differences in pure tones of equal pitch and loudness, but also to describe these quality differences. For example, 250 c/s pure tones are described as purer, clearer, more bell-like than 125 c/s, 2 000 c/s sounds sharp and hard when compared with soft, blunt, more comfortable 125 c/s, whilst 1 500 c/s have a ready quality not observed in 1 000 c/s. The frequency ranges in which such differences of quality exist are tabulated.

A. B. WOOD

534.321.9

3415. Ultrasonics. P. VIGOUREUX. *London, Chapman and Hall* (1950) 163 *pp.*

An introduction is given to the technique of generating and receiving ultrasonic waves, the information being restricted to general principles without details of apparatus and experimental procedure. A simplified theoretical treatment is given of the propagation of ultrasound in liquids, descriptions being given of the effects of viscosity, thermal conduction, and scattering. Methods of measuring velocity and absorption are discussed, most attention being paid to the interferometer, optical diffraction, and echo pulse methods. Descriptions are given of the more important experiments made on liquids and gases by many experimenters during the past decade. As far as the common gases are concerned, it is concluded that, apart from heat conduction and viscosity, absorption arises largely from delay in attaining equilibrium between the translational, rotational, and vibrational energies of molecules, the equilibrium between the first pair being rapidly attained, so that vibration accounts for most of the absorption. The relaxation times of gases are not predictable, and can only be determined by investigating absorption peaks by ultrasonic techniques. The causes of absorption by liquids are not well understood, probably because the relaxation times are so short that sufficiently high test frequencies are not yet available. Apart from the references needed in the text, the bibliography is confined to papers published since Bergmann's book in 1937.

A. C. WHIFFIN

534.321.9 : 534.422

3416. A high power ultrasonic siren. L. PIMONOW. *Ann. Télécommun.*, **6**, 23–6 (*Jan.*, 1951) *In French.*

A discussion is given of the utility and practical applications of detection and production of ultra-sound—e.g. the h.f. sound spectra of aeroplanes and the agricultural application of powerful ultra-sound in the war against insects. A description is given of a motor-driven siren, with a rotor disk having a peripheral speed of 132 m/sec (a second model under construction running at 270 m/sec). The number of teeth on the rotor is 110 and the revolutions 250/sec, whence the ultrasonic frequency of 27·5 kc/s can be attained. It is stated that the acoustic power radiated is about 2 kW. A. B. WOOD

534.321.9 : 548.5

The influence of ultrasonic crystallization kinetics. *See Abstr.* 3906

534.42 : 612.85

3417. Psycho-physical consequences of electro-acoustic sound synthesis. O. SALA. *Frequenz*, **5**, 13–20 (*Jan.*, 1951) *In German.*

An experimental investigation is described in which complex sound impulses are produced by combining a series of synchronous and dependent frequencies of controllable fundamental frequency and logarithmic decrement. The series of frequencies employed have the relative values $1 : 1/n_1 : 1/n_2 : \ldots$ (where n is a whole number). The absolute frequencies are continuously variable by means of capacitance and inductance in the oscillatory circuits. The resultant waveform is displayed on a double-beam oscillograph and a loudspeaker makes the sounds audible to the test subject. A series of experiments is described, using various combinations of tones. The results are discussed in relation to v. Bekesy's theory of hearing, and in their application to electronic organs. A. B. WOOD

534.78

3418. Study of the fundamental physiological and acoustic phenomena of the singing voice. I. R. HUSSON. *Rev. Sci., Paris*, **88**, 67–112 (*April–June*, 1950) *In French.*

The paper, which forms the first part only of the investigation, deals mainly with experimental stroboscopic observations of the movements of the human larynx, under normal conditions and under particular pathological conditions, during the operation of singing. A. B. WOOD

534.78

3419. Representations of speech sounds and some of their statistical properties. S.-H. CHANG, G. E. PIHL AND M. W. ESSIGMANN. *Proc. Inst. Radio Engrs*, **39**, 147–52 (*Feb.*, 1951).

Consideration is given to methods of representing speech sounds as simply as possible without excessive loss of intelligibility. Such methods are applied to the problems of speech compression and sensory replacement. It is considered that the essential elements of speech sounds are statistically invariant because of the structural similarity of vocal mechanisms and the tendency of speakers to conform through the process of learning. The paper is mainly concerned with 4 types of speech representation: the oscillogram, the spectrogram, the auto-correlation function and clipped speech. Mathematically, it is shown that these methods of analysis provide parameters which are equivalent. A. B. WOOD

534.78 : 621.391

3420. Prediction and entropy of printed English. C. E. SHANNON. *Bell Syst. Tech. J.*, **30**, 50–64 (*Jan.*, 1951).

A new method of estimating the entropy and redundancy of a language is described. This method exploits the knowledge of the language statistics possessed by those who speak the language, and depends on experimental results in prediction of the next letter when the preceding text is known. Results of experiments in prediction are given, and some properties of an ideal predictor are developed. A.

534.846.4 : 621.395.623.7

3421. Recent developments in speech reinforcement systems. P. H. PARKIN AND W. E. SCHOLES. *Wireless World*, **57**, 44–50 (*Feb.*, 1951).

Earlier workers have shown that, if two loudspeakers equidistant from the observer are fed with signals of equal magnitude but with a delay of 5–35 msec applied to one of them (the secondary), this speaker will not be heard at all although it will contribute to the sound intensity. Furthermore, under these conditions the primary speaker level can be reduced ~ 7 db before the secondary speaker is heard. With delays > 50 msec, the secondary speaker is heard as an echo and it then detracts from naturalness and intelligibility. Curves, based on many observations, of percentage disturbance *v.* echo delay, up to 140 msec, are given for various levels in the secondary speaker above and below that of the primary. In auditoria there are two main desiderata: (1) that the sound should appear to come from the human speaker; and (2) that the successive sounds heard from the various sources should cause min. disturbance. For a simple high-level system, the desired results can often be obtained by placing a powerful loudspeaker further from the audience than the human speaker. For a low-level system with many loudspeakers, individual optimum positioning, time delays, and intensity levels must be computed. The required procedure is detailed and the results of this technique are applied to an open-air theatre described. H. G. M. SPRATT (R)

OPTICS . RADIATION . SPECTRA 535

535.13 : 538.566

3422. The reflection of an electromagnetic plane wave by an infinite set of plates. III. A. E. HEINS. *Quart. Appl. Math.*, **8**, 281–91 (*Oct.*, 1950).

A continuation of earlier work [Abstr. 1168 (1947), 71 (1948)]. The case in which there are two reflected waves is now studied, and restrictions on the wavelength, angle of stagger and angle of incidence are found. The transmission and two reflection coefficients are calculated, and, as a check, a relation between

these is derived with the aid of the complex form of the Poynting vector theorem. An integral-equation method is used. L. S. GODDARD

535.2 : 539.185

The angular distribution of the radiation at the interface of two adjoining media. *See Abstr.* 3799

535.247.4

3423. An integrating flame photometer for small quantities. J. A. RAMSAY, S. W. H. W. FALLOON AND K. E. MACHIN. *J. Sci. Instrum.*, **28**, 75–80 (*March*, 1951).

A method is described in which the sample is dried on a Pt wire which is then thrust into an air-coalgas flame by a mechanical device. The light from the flame enters a spectrometer and the chosen lines are allowed to fall on a photo-multiplier tube. This is connected to a Miller integrator with meter presentation. The apparatus has been tested with Tl and with Na. A deflexion of about 100 units is given by 10^{-3} mg of Tl and by 10^{-6} mg of Na. The average error is about 3%. This method is intended for use with small volumes, e.g. 10^{-3} mm^3 of biological fluids. The technique of measuring and manipulating these small volumes is described elsewhere. A.

535.31

3424. A four-figure method of ray tracing. W. H. STEEL. Letter in *J. Opt. Soc. Amer.*, **40**, 878 (*Dec.*, 1950).

535.317.4

3425. Correction of pupil aberration in Kellner-type eyepieces. R. S. LONGHURST. Letter in *Nature, Lond.*, **167**, 315–16 (*Feb.* 24, 1951).

535.323

3426. The refractive indices of lithium fluoride. D. S. L. DURIE. Letter in *J. Opt. Soc. Amer.*, **40**, 878–9 (*Dec.*, 1950).

535.323

3427. On the indices of mixtures of two transparent bodies in the form of a thin film. Y. BASSET. Letter in *J. Phys. Radium*, **12**, 65–6 (*Jan.*, 1951) *In French.*

Films are prepared containing cryolite and ZnS evaporated simultaneously from two filaments. The amount of each constituent is estimated by permitting separate pure deposits to be formed alongside the mixed film, and estimating their thicknesses. Composition could be estimated to within 5%. The refractive indices were measured to within 0·01. A curve is given showing the variation of index of the composite film with composition varying from 0 → 100% of the two constituents. S. TOLANSKY

535.33–12/14

3428. Spectroscopy at radiofrequencies. B. BLEANEY. *Nature, Lond.*, **167**, 133–5 (*Jan.* 21, 1951).

An informative review of the Amsterdam conference on spectroscopy, Sept. 18–23, 1950, which had sections on paramagnetic resonance, ferromagnetic resonance, atomic and molecular spectra and nuclear properties. D. H. WHIFFEN

535.33.07–15

3429. Principles of infrared spectrophotometry. V. Z. WILLIAMS, R. C. HAWES AND W. S. GALLAWAY. *Science*, **113**, 51–4 (*Jan.* 19, 1951).

Instruments are divided into 5 design groups; 3 measuring percent transmission directly, 2 measuring energy. Advantages of each are considered with respect to noise, recording time, atmospheric interference, etc. Commercial examples of the different groups are considered. G. F. LOTHIAN

535.331

3430. Structure and Zeeman-effect in the spectrum of the tantalum atom Ta I. P. F. A. KLINKENBERG, G. J. VAN DEN BERG AND J. C. VAN DEN BOSCH. *Physica*, **16**, 861–89 (*Dec.*, 1950).

The analysis of existing wavelength data of the Ta I spectrum results in the detection of 6 ground levels and numerous higher terms, in addition to those reported by previous investigators. The total number of classified lines is now 687. They correspond to combinations between 19 even ground levels and 98 odd high levels. The Zeeman effect is investigated in the region 2 500–8 500 Å and the g-values of practically all levels can be determined. The low terms belong to the configurations $5d^36s^2$ and $5d^46s$; no levels of $5d^5$ could be detected. The odd levels originate in the configurations $5d^26s^26p$, $5d^36s6p$ and $5d^46p$, the most important multiplets of which can be identified. A.

535.332

3431. Hyperfine structure in the spectrum of bromine. II. J. D. RANADE. *Phil. Mag.*, **42**, 284–90 (*March*, 1951).

Measurements for the hyperfine structures of 18 classified and 21 unclassified lines of the first spark spectrum of Br are reported. The spectrum was excited by a high-frequency electrodeless discharge in pure Br_2 vapour. The patterns are analysed and interval factors for 14 terms are given. A.

535.332 : 537.228.5

3432. On the Stark effect of the line Hα. T. SAKURAI. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A.*, **1**, 283–94 (*Oct.*, 1949).

Weak-field observations were made, using a new canal ray tube, at 14 790 V/cm. Some enhancements and asymmetries were observed, attributed to inequalities of the number of atoms in initial excited states. The first-order Stark effect coefficient was measured as $6{\cdot}44 \times 10^{-5} \pm 0{\cdot}3\%$. A.

535.338.3

3433. Study of the perturbation of the 1 469 Å line of xenon by argon under pressure up to 650 kg/cm^2. S. ROBIN AND J. ROMAND. *C.R. Acad. Sci., Paris*, **231**, 1455–8 (*Dec.* 18, 1950) *In French.*

Under compression this line spreads into a band whose displacement from the maximum as function of A density is examined. For weak partial pressure of Xe it shifts → shorter wavelengths, and the displacement changes more rapidly than linearly for higher A density. For higher pressure the shift is → longer wavelength. Under increased A pressure the short-wavelength edge moves → shorter wavelength, the other remaining fixed, leading to an asymmetrical shift of the maximum. J. JACOBS

535.338.333

3434. Isotope shifts in enhanced samarium isotopes. D. D. SMITH AND J. R. MCNALLY, JR. Letter in *J. Opt. Soc. Amer.*, **40**, 878 (*Dec.*, 1950).

535.338.4

3435. Two new band systems of the AlCl molecule. D. SHARMA. *Astrophys. J.*, **113**, 210–18 (*Jan.*, 1951).

An uncondensed discharge in a tube containing $AlCl_3$ vapour and He shows two groups of bands in the regions $\lambda\lambda$4154–3970 and $\lambda\lambda$5612–5265, the former ones being degraded to shorter and the latter to longer wavelengths. The $\lambda\lambda$4154–3970 bands are found to be analogous to the Cameron bands of CO, being due to a transition from the first excited triplet state $a^3\Pi$ to the ground state $X^1\Sigma^+$ of AlCl. The other bands have the $a^3\Pi$ state as their lower state and probably $a^3\Sigma$ state as their upper state. Only the $(0, v'')$ progression of these bands is observed, possibly indicating a predissociation at $v' = 1$ in the $^3\Sigma$ state. A.

535.338.4

3436. A new band system of the AlBr molecule. D. SHARMA. *Astrophys. J.*, **113**, 219–21 (*Jan.*, 1951).

New bands, shaded to shorter wavelengths, in the region $\lambda\lambda$4370–4040 have been observed in a discharge tube containing AlBr vapour and He. They have been analysed and found to belong to the intercombination $^3\Pi \rightarrow {}^1\Sigma$ transition. A.

535.338.4 : 539.133

3437. An infra-red band-system of calcium oxide. M. HULTIN AND A. LAGERQVIST. *Ark. Fys.*, **2**, *Paper* 45, 471–507 (1951).

A rotational analysis has been made of 16 bands of a transition $^1\Sigma^* - {}^1\Sigma$ in CaO. The more important constants (cm^{-1}) are: $\nu_{0,0} = 11\,548{\cdot}8$; $\omega' = 732{\cdot}1_1$; $x_e''\omega_e'' = 4{\cdot}8_1$; $\omega_e' \sim 716$; $x_e'\omega_e' \sim 1{\cdot}6$; $B'' = 0{\cdot}4444_7 - 0{\cdot}0033_5(v + \frac{1}{2}) + 0{\cdot}00000_5(v + \frac{1}{2})$; $B' = 0{\cdot}4063 - 0{\cdot}0014_1\ (v + \frac{1}{2})$. An earlier analysis [Brodersen, *Z. Phys.*, **104**, 135 (1936)] is incorrect. The upper $^1\Sigma^*$ state is much perturbed. Six perturbing states or sub-states have been revealed, four with $\omega \sim 500$ and $B \sim 0{\cdot}33$, two with $\omega \sim 600$ and $B \sim 0{\cdot}38$. Formulae for the determination of vibrational and rotational constants for the interaction of three states are given, and the general case of n interacting terms is also considered.

R. F. BARROW

535.339.4

3438. On the Christiansen filter and a modification thereof. T. CARLSEN. *Trans Danish Acad. Sci., No.* 7, 32 *pp.* (1950).

A review of the theory of the Christiansen filter and a comparison of its performance with that of the prism monochromator. The modified form of the filter, using numerous small prisms immersed in liquid, is investigated. Practical details of the modification are given and experimental measurements show that the bandwidth is of the same order as that of a prism monochromator, although the filter can have a much larger area. 46 references are given. R. W. FISH

535.343 : 539.132

3439. Calculation of the fundamental vibration frequencies of cyclohexane. M. LARNAUDIE. *C.R. Acad. Sci., Paris*, **232**, 316–18 (*Jan.* 22, 1951) *In French.*

Calculated frequencies [for details of the method, see Abstr. 2894 (1951)] are listed: they are in satisfactory agreement with the experimental values.

R. F. BARROW

535.343–15 : 535.375.5

3440. Spectral properties of the carbonyl radical: comparison between the vibration spectra (Raman effect and infra-red) of ketones and aldehydes. E. GRAY. *C.R. Acad. Sci., Paris*, **231**, 1452–3 (*Dec.* 18, 1950) *In French.*

Claims that the C = O stretching vibration frequency near 1 750 cm^{-1} as observed in the Raman effect is less than that observed in i.r. absorption for several ketones and aldehydes. The same shift is present in the liquid, in dilute solution and in the solid, and shifts up to 26 cm^{-1}, the value for butyric aldehyde, are claimed. D. H. WHIFFEN

535.343.2–15

3441. Effect of changes in crystalline structure on the infrared absorption spectrum of cellulose. F. H. FORZIATI AND J. W. ROWEN. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 38–42 (*Jan.*, 1951).

535.343.3–15

3442. Remarks on the absorption spectrum of liquid benzene in the near infra-red. G. GAUTHIER. *C.R. Acad. Sci., Paris*, **231**, 1453–5 (*Dec.* 18, 1950) *In French.*

Measurement of the overtone and combination bands of liquid benzene, especially near 1·4 μ. All bands can be interpreted with the strict selection rules for D_{6h} symmetry. D. H. WHIFFEN

535.343.4

3443. Absorption spectra of thallium halides. P. TIRUVENGANNA RAO. *Indian J. Phys.*, **24**, 434–40 (*Oct.*, 1950).

The absorption spectra of TlI, TlCl and TlBr have been investigated in the region λ6500–λ2200. An examination of the new absorption photographs obtained for TlI in the present work, has led to an important modification in the analysis of the main system $^3I - {}^1\Sigma^+$, reported earlier in emission [Abstr. 141 (1950)]. The origin had to be located at ν26339·6 instead of at ν25780·0 and the vibrational quantum numbers v' and v'' had to be increased by 11 and 13 units respectively. No systems of TlI attributable to the transitions $^3O^+ - {}^1\Sigma^+$ and $^1\Pi - {}^1\Sigma^+$ have been obtained in absorption. The two systems of TlCl lying between λ4200–λ3800 and one for TlBr in the region around λ3950 reported in emission have not occurred in absorption. A.

535.343.4

3444. Formaldehyde spectrum in the glow discharge. H. SCHÜLER AND L. REINEBECK. *Z. Naturforsch.*, **5a**, 604–7 (*Nov.*, 1950).

New bands have been found which do not fit in with existing term schemes. They are considered as deriving from transitions between two excited states of the formaldehyde molecule, the higher being a singlet state and the lower a triplet state. The triplet states are only seen in one absorption band. In addition there has been observed a spectrum formerly seen only in the flame and attributed to the CHO radical. J. EWLES

535.343.4–15 : 551.593.52

3445. The absorption of atmospheric vapour in the near infrared (the bands at 2·7 and 1·8 μ). R. MATHIS. *J. Phys. Radium*, **12**, 51–64 (*Jan.*, 1951) *In French.*

The band near 2·7 μ contains 2 transitions from the ground state, $\nu_1(1, 0, 0)$ and $\nu_3(0, 0, 1)$, with 186 vibration-rotation lines. The band near 1·87 μ is the transition to $\nu_2 + \nu_3(0, 1, 1)$ accompanied by 183 vibration-rotation lines. For each of these 3 states the moments of inertia, O–H distance, and H–O–H angle are redetermined. J. JACOBS

535.343.4–34

3446. Absorption spectrum of anisole. K. SREERAMAMURTY. *Indian J. Phys.*, **24**, 421–33 (*Oct.*, 1950).

The ultra-violet absorption spectrum of anisole vapour has been photographed in the region λ2840–2350. Most of the observed band heads have been interpreted in term of the ground state, the excited state and difference frequencies. Difference frequencies of 26, 56 and 25 cm^{-1} have been newly proposed. The data were compared with the results of earlier investigations on Raman effect and ultra-violet absorption. A.

535.343.4–34

3447. The absorption spectrum of 1 : 1-dichloro-ethylene in the vacuum ultra-violet. J. P. TEEGAN AND A. D. WALSH. *Trans Faraday Soc.*, **47**, 1–7 (*Jan.*, 1951).

The absorption spectrum of 1 : 1-dichloro-ethylene has been photographed in the region 2 100–1 100 Å. The spectrum appears to be due to 2 types of transition: (*a*) transitions of an electron initially present in the π-orbital of the C=C bond, (*b*) transitions of an electron initially present in an orbital largely localized around a Cl atom. Among the (*a*) transitions a Rydberg series is found which converges to a limit of 9·47 V. The (*b*) transitions appear to converge to a limit of ~ 10·4 V. The π^{-1} ionization potential is less than the corresponding value for either *cis*- or *trans*-dichloro-ethylene. The convergence limit of the (*b*) bands is less than the corresponding limit in ethyl chloride. An interpretation of these two facts is advanced which regards them as related consequences of the repulsive effects of two adjacent Cl atoms. A comparison of the chloro- and methyl-ethylenes is made, and correlations of thermodynamic and ionization data are given. These correlations are interpreted as due to varying degrees of conjugation, which are explained in terms of geometrical shape and repulsion effects. A.

535.371

3448. The interrelation of temperature and concentration extinction in some crystal phosphors. YA. M. ZELIKIN, N. I. IVANOVA AND F. D. KLEMENT. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 2) 181–4 (1950).

It is found experimentally that a close connection exists between extinction due to heating and that due to activator concentration. Concentration extinction is strongest at high temperatures and temperature extinction is greatest at activator concentrations near the optimum. Photographic photometry was used for examining the intensity of radiation at 5 300 Å excited in ZnS(Cu), NH_4NO_3(Tl), and $BaCl_2$(Cu) by a high-pressure Hg arc. The results are interpreted using Mott's formula [*Proc. Roy. Soc. A*, **167**, 384 (1938)]. A. L. MACKAY

535.371

3449. The polarization fluorescence of vapours of organic dyes. K. K. SHENDRIK AND A. G. SIRYUK. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 665–7 (1950) *In Russian.*

Measurements were made of the degree of polarization of the fluorescent radiation excited in organic dyes by a super-high-pressure Hg lamp. Both a Savart polariscope and a photographic method were used and the accuracy of the results (2%) was checked by examining the fluorescence of a glycerine solution of anthracene for which the degree of polarization was already known as a function of viscosity. The fluorescence from anthracene vapour at 104°C was found to be 5 ± 2% polarized, but no polarization was detected for the vapours of rhoduline orange nor for certain phthalimides at about 160–200° C.

A. L. MACKAY

535.371

3450. Fluorescence decay of scintillation crystals. S. H. LIEBSON, M. E. BISHOP AND J. O. ELLIOT. Letter in *Phys. Rev.*, **80**, 907–8 (*Dec.* 1, 1950).

Using a quartz-crystal oscillator type of fluorometer decay times of several scintillation crystals are measured for u.v. excitation and compared with results for γ-ray excitation. Discrepancies are found which are not accounted for. G. F. J. GARLICK

535.371

3451. Luminescent efficiency of organic solutions and crystals. P. D. JOHNSON AND F. E. WILLIAMS. Letter in *Phys. Rev.*, **81**, 146 (*Jan.* 1, 1951).

535.371

3452. Molecular structure of peripheral layers of phosphors. B. PRÉGEL. *C.R. Acad. Sci., Paris*, **232**, 320–1 (*Jan.* 22, 1951) *In French.*

A continuation of previous work [Abstr. 215 and 966 (1951)]. X-rays developed at 150 kV were used. The phosphor was Li_2CO_3 with $SrCO_3$ activated with $RbNO_3$ and $Bi(NO_3)_3$. The spectral bands emitted lay between 1 800 and 2 400 Å. Microphotographs taken with an electron microscope show that the peripheral layers consist of crystalline "cells" of perfect regularity. The mosaic of "cells" varies with intensity and time of excitation and from time to time appear large cells among the regular pattern of small cells. Three photographs are given showing the microstructures after different excitations. One of these, the result of re-excitation of half the sample at an interval of 3 min after previous saturation excitation of the whole sample shows a gliding of the re-excited pattern with reference to the other part. J. EWLES

535.371

3453. On a new phenomenon observed at the time of excitation of phosphorescent bodies with several activators. B. PRÉGEL. *C.R. Acad. Sci., Paris*, **232**, 613–15 (*Feb.* 12, 1951) *In French.*

On excitation by 150 kV X-rays, 0·7% of the applied energy reappeared as free electrons which were not due to a photoelectric effect. The effect was observed either in air or in high vacuum. S. T. HENDERSON

535.371

3454. Scintillations produced in liquids by high-energy radiation: αα′ dinaphthyl as a scintillating medium. E. H. BELCHER. Letter in *Nature, Lond.*, **167**, 314 (*Feb.* 24, 1951).

535.371

3455. Cathodoluminescence of zinc orthosilicate with manganese activator. S. LARACH AND R. E. SHRADER. Letter in *J. Appl. Phys.*, **22**, 362 (*March*, 1951).

535.371 : 548.7

3456. On the origin of fluorescence in diamond. B. M. BISHUI. *Indian J. Phys.*, **24**, 441–60 (*Oct.*, 1951).

The fluorescence and absorption in the visible region exhibited by 6 specimens of diamond including one of type II have been investigated at different temperatures and the birefringence shown by these crystals at 30°C and 275°C has been photographed. The intensity of fluorescence excited by different monochromatic radiations in the region of 4 046 Å has also been studied qualitatively. The results show that the integrated intensity of the band at 4 156 Å increases at lower temperatures and, diminishing gradually with the rise of temperature of the crystal, it vanishes abruptly at a temperature which is different for the different crystals; but at 275°C the band is absent in all the cases. The absorption band at 4 156 Å and its companions also disappear at 275°C, but the birefringence shown by the crystals is not altered very much at this temperature. It has been concluded that the fluorescence behaves in the same way as impurity fluorescence and that the impurity is of chemical nature; the fluorescence is not due to lattice defect, because there is no exact correlation between microscopic strain and fluorescence in diamonds of type I. A.

535.372

3457. Luminescence of K_4MnCl_6 and KCl (Pb + Mn). R. J. GINTHER. *J. Electrochem. Soc.*, **98**, 74–81 (*Feb.*, 1951).

Excitation and emission spectra K_4MnCl_6 and KCl(Pb + Mn) are reported. A method for the preparation of K_4MnCl_6 from solution at room temperature is described. Lead and thallium are shown to produce sensitized luminescence in this phosphor. A.

535.372

3458. On the X-ray luminescence spectra of thallium-activated alkali halide crystals. A. CHATTERJEE. *Indian J. Phys.*, **24**, 331–8 (*Aug.*, 1950).

The X-ray luminescence spectra of Tl-activated alkali halides have been investigated at ordinary and low temperatures. The band systems are of two types; the visible part is due to the lattice emission, while the short-wavelength part exhibits characteristic Tl emission. The lattice bands gain in intensity due to the presence of Tl. The intensity of the characteristic band is linearly related to the concentration of Tl. It has been shown that Seitz's explanation of the characteristic Tl band emission is inadequate, and an alternative energy-level scheme has been proposed. A.

535.375.5

3459. Lattice frequencies of benzene crystal. I. ICHISHIMA AND S.-I. MIZUSHIMA. Letter in *J. Chem. Phys.*, **18**, 1686–7 (*Dec.*, 1950).

Attributions by Frühling [Abstr. 8641 (1950)] of 63 and 105 cm^{-1} to rotational oscillations about axes in the plane of the molecule, and of 35 and 69 cm^{-1} to rotations about the hexagonal axis, are difficult to reconcile with results of experiments made by one of the authors on the variation of frequency of these lines with temperature. Alternative allocations are put forward. A. C. MENZIES

535.375.51

3460. On the temperature-dependence of the intensity of lines in the combination scattering [Raman] spectra of some liquids. L. M. FISHKOVA. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 4) 523–6 (1950) *In Russian.*

An investigation of the intensity of the Stokes lines for CCl_4, C_6H_6 and C_6H_5Cl using photoelectric detection, shows that the integrated intensities, I, for each line measured decreases with rising temperature in the range -20 to $+70$°C. Typical is the 313 cm^{-1} line for CCl_4 where $I_{-15°C}/I_{+73°C} = 2{\cdot}36$, a factor which is in disagreement with the common theory which gives $I \propto 1/[1 - \exp(-h\nu/kT)]$ and predicts an increase of intensity with temperature. Variations in density and refractive index are too small to account for this discrepancy, and it is suggested that molecular interactions and association must be invoked. D. H. WHIFFEN

535.375.54

3461. On the Raman spectra of three mono-substituted *n*-butane compounds in the solid state. S. B. SANYAL. *Indian J. Phys.*, **24**, 378–86 (*Sept.*, 1950).

The Raman spectra of *n*-butyl bromide, *n*-butyl amine and *n*-butyl alcohol have been studied in the solid state at about -150°C and compared with those of the corresponding liquids at about 30°C. It is observed that most of the lines due to the oscillations of the C–C–C–C chain disappear with the solidification in all these cases. Also, two intense lines at 558 cm^{-1} and 642 cm^{-1} due to C–Br valence oscillations are observed in the case of butyl bromide in the liquid state, but the line 558 cm^{-1} disappears when the liquid is solidified. It has been pointed out that the results cannot be explained by assuming that two forms of isomeric single molecules are present in the liquid state, and that one of the forms disappears in the solid state, as has been done previously, and also that if association of molecules in the liquid state is postulated, the results can be explained satisfactorily. A.

535.376 : 539.23

3462. Scintillations from thin films. E. W. T. RICHARDS AND J. F. I. COLE. Letter in *Nature, Lond.*, **167**, 286 (*Feb.* 17, 1951).

It is claimed that thin films of many different materials emit luminescence scintillations when bombarded by α-particles. It is found that the emission disappears when the film thickness exceeds the particle range. G. F. J. GARLICK

535.379 : 541.14

3463. Hydration of quinine sulphate and the accompanying luminescence and electrical phenomena. M.

PROST. *J. Phys. Radium*, **11**, 673–82 (*Dec.*, 1950) *In French.*

Hydration of quinine sulphate is accompanied by fluorescence emission and ionization of the air in contact. These effects are traced to a u.v. emission and an explanation in terms of this emission is attempted. G. F. J. GARLICK

535.39

3464. A method for production of interference filters for specified wave-lengths. A. HERMANSEN. *Nature, Lond.*, **167**, 104–6 (*Jan.* 20, 1951).

A description is given of an optical device for controlling uniformity and thickness of evaporated metal and dielectric films for the production of interference filters. The glass receiving plate is rotated during deposition, and the sources are arranged to give uniformity of dielectric to within 0·5%. Thickness is observed by a polarimetric method based on phase change on reflection. Calculations are made for low and high refractive-indices (1·2 and 2·3) on Ag. The refractive index of cryolite is measured and given as 1·20. A shift to the red of about 100 Å is found for filters shortly after manufacture when a fluoride filter is made; this rises to 400 Å if a glass cover is balsam-cemented on the filter and the effect is attributed to filling in of pores. ZnS filters do not show the effect and there appear to be no pores in this case. S. TOLANSKY

535.39 : 535.51

3465. Examination of metals under polarized light. I. Theory and apparatus. B. W. MOTT AND H. R. HAINES. *Research, Lond.*, **4**, 24–33 (*Jan.*, 1951).

A review article which begins with general references to previous work on the reflection of light from metals. Cubic materials, uniaxial crystals, orthorhombic crystals, monoclinic and triclinic crystals are discussed in detail. The effects of anisotropic surface films, etching and reflection from transparent inclusions are mentioned. The apparatus required for the microscopical examination is described, each component being treated in detail from the point of view of obtaining the highest efficiency of the optical system. H. G. JERRARD

535.43

3466. Small angle diffraction of light by a glass cube. A. T. FORRESTER AND L. MITTENTHAL. *Phys. Rev.*, **81**, 268–71 (*Jan.* 15, 1951).

Experiments on the diffraction of light by a glass cube failed to yield results compatible with a theory of Halpern and Gerjuoy. Although it is possible that the anomalously large amount of scattering predicted by the theory could have been counteracted by the effects of the clamping of the cube, this seems very unlikely. The remaining alternative appears to be that the use of Born approximation in the theory is unjustified. A.

535.435

3467. Polarisation of Brillouin components in light-scattering in liquids. C. S. VENKATESWARAN. Letter in *Curr. Sci.*, **20**, 14 (*Jan.*, 1951).

535.435 : 621.383 : 621.317.39

3468. Electronic differential nephelometer. E. DEL PIANTO AND I. F. QUERCIA. *Ric. Sci.*, **20**, 1658–61 (*Nov.*, 1950) *In Italian.*

A photoelectric system using two photocells of the emissive type in a balanced twin circuit, the balance being measured by a Wheatstone bridge arrangement using the amplification of the two halves of a double triode. The sensitivity of the apparatus is 1 V p.d. for 0·002 lumen difference in illumination. This nephelometer has been designed for bacteriological and microbiological work. W. SUMMER (R)

535.551 : 539.374

3469. Stress birefringence in polyethylene. S. M. CRAWFORD AND H. KOLSKY. *Proc. Phys. Soc., Lond. B*, **64**, 119–25 (*Feb.*, 1951).

The birefringence and strain produced in polyethylene by different stresses have been measured at temperatures between 20° and 90°C. The relation between strain and birefringence is linear up to strains of 0·25 and for greater strains there is still no hysteresis. This indicates that no true flow occurs in this temperature range. The stress-birefringence relation, on the other hand, rapidly departs from linearity and shows large hysteresis, so that the nature of the birefringence effects is in direct contrast with that observed in rubber. An expression has been derived for the birefringence in terms of the orientation of rod-like crystallites embedded in an elastic matrix and this was found to be in qualitative agreement with the experimental results. A.

535.8

3470. Optical techniques and apparatus for the quantitative measurement of variations in density. I and II. W. WOEHL. *Arch. tech. Messen, Issue No.* 179 (*Ref. Z*721–1) T141–T143 (*Dec.*, 1950) *In German.*

A general review of the schlieren and shadowgraph techniques for measuring small local changes in optical density. The theory and practice of familiar methods are discussed and the method of quantitative evaluation described. Fifty-eight references are included. No new techniques are described. S. TOLANSKY

535.8

3471. Optical techniques and apparatus for the quantitative measurement of variations in density. III and IV. W. WOEHL. *Arch. tech. Messen, Issue No.* 180 (*Ref. Z*721–2) T10–T12 (*Jan.*, 1951) *In German.*

A general review of optical interference methods for measuring small local changes in optical density. The methods described involve (*a*) the Jamin interferometer, (*b*) the Mach–Zehnder interferometer. Fringe localization and method of adjustment are discussed in detail. A description is given of a compound schlieren and interferometric device. Comparative sensitivity of shadow, schlieren and interferometer methods are discussed. S. TOLANSKY

535.8 : 526.2

The electric eye [geodetic surveying]. *See Abstr.* 3305

535.822.9

3472. Phase contrast units using an ordinary microscope. M. FRANÇON AND G. NOMARSKI. *Rev. Opt. (Théor. Instrum.)* **29**, 619–31 (*Dec.*, 1950) *In French.*

Describes 2 units which will transform an ordinary

microscope into a phase-contrast instrument. The first is inserted between the object and the microscope O.G. and allows the use of the highest-power immersion objectives. The use of a variable phase plate is also described. The second unit is placed after the eyepiece and yields an image in phase contrast by reflection, with the possibility of variable absorption. This unit is particularly valuable for metallographic microscopy with a vertical illuminator. R. W. FISH

535.822.9

3473. A flying-spot microscope. J. Z. YOUNG AND F. ROBERTS. Letter in *Nature, Lond.*, **167**, 231 (*Feb.* 10, 1951).

In this arrangement the specimen is scanned by a spot of light obtained from a television raster of high brilliance on a c.r.t., the spot being reduced in size by a normal microscope. The light transmitted by the specimen falls upon a photo-multiplier tube and the output is used to modulate a raster on a second, projection-type c.r.t. Among the advantages claimed are the large, brilliant display, greater resolution, increased quantum efficiency of photo-multiplier tube compared with a photographic plate, the possibility of varying the image contrast electronically, and the possibility of quantitative analysis of an image, particles being counted and sized at a rate of a million per second. R. W. FISH

535.822.9 : 535.42

3474. Elimination of the unwanted image in diffraction microscopy. W. L. BRAGG AND G. L. ROGERS. Letter in *Nature, Lond.*, **167**, 190–1 (*Feb.* 3, 1951).

When an object is reconstructed from a hologram, two images are formed and the image in sharp focus has as a background a confused pattern due to the other image. It is possible to eliminate the effects of the unwanted image by taking a subsidiary hologram and subtracting it from the reconstruction. Practical details and photographs illustrating the possible improvements are given. R. W. FISH

535.822.9 : 535.424

3475. On the theory of the phase-contrast microscope. L. FALLA. *Bull. Soc. Roy. Sci. Liège*, **19**, 382–400 (*Aug.–Sept.–Oct.*, 1950) *In French.*

By means of a vector diagram it is shown that the direct and diffracted light emerging from an illuminated transparent object show a phase-difference of $\pi/2$, even when the phase-structure of the object is of large variation. This result is confirmed, using the method of complex Fourier series due to Zernicke. The contrast in the image of a phase-grating of phase difference ϕ is shown to be $2 \sin \phi/(1 + \sin \phi)$, which reduces to the known value 2ϕ, when ϕ is small. If the phase-plate has a transmission $1/N$ and a phase-change $= \phi'$ (instead of 1 and $\pi/2$), a slightly more complicated formula results. It is shown that, in general, the phase-image will be coloured.

H. H. HOPKINS

535.827.14

3476. A low-power micromanipulator and microdissector. R. BARER AND A. E. SAUNDERS-SINGER. *J. Sci. Instrum.*, **28**, 65–8 (*March*, 1951).

Factors which must be considered in the design of a low-power micromanipulator are discussed. A rough prototype model is described and it is shown how the final instrument was evolved from this. The instrument is completely three-dimensional, will follow a movement of the hand with a reduction ratio of 4 to 1, and will "stay put" in any position. It is intended for use at magnifications up to 200 times, and the movement, as seen through a binocular dissection microscope, is not reversed. A.

535.87

3477. The preparation of pinhole-free silver mirrors. E. BOVEY AND P. UNGER. *J. Sci. Instrum.*, **28**, 68–70 (*March*, 1951).

Following a comparison of various known silvering processes, a modified form of the Brashear process was devised. This process could be operated successfully when the component solutions were at room temperature within the range 12–26°C, thus avoiding the well-known difficulties associated with changes in the ambient temperature. Pinhole-free mirrors were then prepared by adopting special cleaning techniques in conjunction with the above improved Brashear process. A.

HEAT 536

536.2

3478. A theory of the envelope type of thermal conductivity tests. A. L. LOEB. *J. Appl. Phys.*, **22**, 282–5 (*March*, 1951).

The well-known problem of the end effects in a cylinder of finite length has been circumvented by the use of spheroidal rather than cylindrical apparatus. After a general theory of heat flow is given, applications demonstrate the mathematical difficulties caused by discontinuities in the curvature of the surface of the heat conductor. The suitability of the spheroidal shape is demonstrated, and corresponding heat flow equations are derived demonstrating the effects of the variable distance between any two isotherms on the amount of heat crossing any unit area of an isotherm. It is proved that the amount of heat flowing through a slice of a spheroidal isotherm made perpendicular to the axis of the spheroid is proportional to the width of the slice, and independent of the position of the slice with respect to the spheroid. This theorem is applied to find the heat distribution necessary to keep the core of the apparatus at uniform temperature. Because all measurements are made at thermal equilibrium, a rough estimate is given for the time necessary to reach equilibrium. A.

536.212.2

3479. The thermal conductivity of a copper-nickel alloy at low temperatures. J. K. HULM. *Proc. Phys. Soc., Lond. B*, **64**, 207–11 (*March*, 1951).

The thermal and electrical conductivities of an alloy of 80% Cu and 20% Ni with average crystal grain size 0·011 mm have been measured at liquid hydrogen and liquid helium temperatures. A comparison of the results with Makinson's theory suggests that the thermal conductivity between 2°K and 20°K is the sum of a temperature-proportional term due to electron transport with impurity scattering and a T^2-proportional term due to lattice wave transport

with electron scattering, both terms being of the same order of magnitude. A.

536.41 : 666.1.037.5

3480. The control and application of the expansion characteristics of metals and alloys. H. H. SCHOLEFIELD. *Trans Instrum. Meas. Conf., Stockholm* (1949) 260–7 (1950).

An account of recent research in the production of glass-to-metal sealing alloys, including work on Ni–Fe and on glasses. Work on bimetals, low-expansion alloys, and special spring alloys and magnetostriction alloys is recorded with graphical results. E. H. W. BANNER (R)

536.413 : 536.421

3481. The thermal expansion coefficient and the melting point of cubic elements. D. VAN DER REYDEN. Letter in *J. Appl. Phys.*, **22**, 363 (*March*, 1951).

536.421.4

3482. Linear problem of Stephan: case of alternating phases. A. B. DATSEV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 631–4 (1950) *In Russian.*

A solution on mathematical lines is proposed for the general problem of Stephan (that of congelation) in the case of a number of alternating solid and liquid phases occurring in a body, e.g. water, ice or damp earth, where frozen layers exist. The method is easily applicable when one of the intermediate phases is evanescent. But the case of an intruding phase, e.g. of ice in the cooling of a water layer from one side, would need further investigation, the method expounded not being directly applicable to it.

J. CLEUGH

536.422

3483. Rates of evaporation. IV. The rate of evaporation and vapour pressure of rhombic sulphur. R. S. BRADLEY. *Proc. Roy. Soc. A*, **205**, 553–63 (*March* 7, 1951).

See Abstr. 5391 (1949) for Part III. The rate of evaporation *in vacuo* and vapour pressure of bipyramidal crystals of rhombic S ({111}) have been determined in the range 15 to 32·5°C; the rate of evaporation of a polycrystalline bead of rhombic S has been determined at 30°C over a range of air pressures. The diffusion coefficient of S_8 molecules in air is 0·0884 $cm^2\ sec^{-1}$ at 30°C; the evaporation coefficient is 0·73 ± 0·05 and appears to be temperature independent over the range studied. The linear velocity of the interface on evaporation is given by $1{\cdot}91\times10^{11}T^{-\frac{1}{2}}e^{-23\,890/RT}$ cm sec^{-1}. The vapour pressure is given by $\log_{10} p\ \text{cm} = -5\,240/T + 10{\cdot}763$. The temperature-independent factor for the rate of evaporation and the value of the evaporation coefficient are discussed in terms of statistical mechanics. A.

536.422.1

3484. The evaporation of titanium. L. G. CARPENTER AND W. N. MAIR. *Proc. Phys. Soc., Lond. B*, **64**, 57–66 (*Jan.*, 1951).

Data are presented on the evaporation rate of β-titanium over the temperature range 1 650–1 810°K. These are represented by $\log ET^{1/2} = -2{\cdot}42T^{-1} + 9{\cdot}79$, where E is in $g.cm^{-2}\ sec^{-1}$ and T is in degrees K. The latent heat of vaporization is deduced both from the measured values of evaporation rate, together with known thermodynamic functions of the solid and gas, and also from the temperature coefficient of evaporation rate. An estimate is made of the variation of total radiation with temperature, and of the vapour pressure at the melting-point. Experimental details are given. A.

536.423

3485. Condensed gas calorimetry. II. Heat capacity of ortho-deuterium between 13·1 and 23·6°K, melting and boiling points, heats of fusion and vaporization. Vapor pressures of liquid ortho-deuterium. E. C. KERR, E. B. RIFKIN, H. L. JOHNSTON AND J. T. CLARKE. *J. Amer. Chem. Soc.*, **73**, 282–4 (*Jan.*, 1951).

The heat capacities of solid and liquid ortho-deuterium (97·8%) have been measured and tabulated, for the temperature range 13·66 to 22·73°K. In addition, the temperature and the pressure at the triple point were determined as 18·63 ± 0·01°K, and 12·75 ± 0·5 Int. cm, respectively. Heats of fusion and of vaporization were found to be 47·07 ± 0·1 and 293·93 ± 0·5 cal/mole, respectively. Vapour pressures were measured for the liquid range, and fitted accurately by the equation $\log P\ (\text{mm}) = 4{\cdot}70099 - (56{\cdot}7247/T) + 0{\cdot}02478T$. The entropy of the ideal gas at 23·59°K and 1 atmos. pressure totals 21·43 ± 0·09 e.u., with nuclear spin entropy included, which is in good agreement with the value of 21·35 ± 0·01 e.u., calculated from the spectra of deuterium. A.

536.423 : 541.6

3486. The rate of evaporation of droplets. V. Evaporation characteristics of some branched-chain hydrocarbons and a straight-chain fluorocarbon. R. S. BRADLEY AND G. C. S. WAGHORN. *Proc. Roy. Soc. A*, **206**, 65–72 (*March* 22, 1950).

See Abstr. 3483 (1951) for Part IV. The vapour pressures, latent heats of vaporization and densities have been determined for $(C_7H_{15})_3CH$ and $(C_{10}H_{21})_3CH$ at 25 to 40°C, and the rate of evaporation of droplets has been studied at a range of air pressures at 25 to 35°C. Diffusion coefficients in air and collision radii have been calculated. The evaporation coefficient is unity. For n-$C_{16}F_{34}$ the vapour pressure and heat of sublimation have been determined at 15 to 30°C, and the values of diffusion coefficients and collision areas have been determined from the evaporation characteristics of solid beads. A comparison has been made of the data for straight- and branched-chain hydrocarbons, and for straight-chain fluoro- and hydrocarbons. A.

536.423.15

3487. Vapor pressure of inorganic substances. IV. Tantalum between 2624 and 2493°K. J. W. EDWARDS, H. L. JOHNSTON AND P. E. BLACKBURN. *J. Amer. Chem. Soc.*, **73**, 172–4 (*Jan.*, 1951).

This was determined by measuring the rate at which a metal surface evaporates in vacuum. Values of ΔH_0^0 were calculated from the individual vapour pressures and showed no appreciable trend, the average value being 185·5 ± 0·3 kcal. By combining this value with free energy functions for solid

and gaseous Ta, the following equation was obtained: $R \ln p = -(185{\cdot}5\times10^3)/T + 3{\cdot}7\times10^{-4}T - 8{\cdot}4\times10^{-8}T^2 + 32{\cdot}87$. A.

536.423.15

3488. The vapor pressure of inorganic substances. V. Zirconium between 1949 and 2054°K. G. B. SKINNER, J. W. EDWARDS AND H. L. JOHNSTON. *J. Amer. Chem. Soc.*, **73**, 174–6 (*Jan.*, 1951).

This has been determined by measuring the rate at which a Zr surface evaporates into a vacuum. Values of ΔH_0^0 have been calculated from the individual vapour pressures and show no appreciable trend, the average value being 142 150 ± 350 cal/mole. By combining this value with free energy functions of gaseous Zr and with extrapolated values for the solid, the following equation is obtained: $\log P\,(\text{atm.}) = -(31\,066/T) + 7{\cdot}3351 - 2{\cdot}415\times10^{-4}T$. A.

536.423.15

3489. Vapour pressure and rate of evaporation. I. N. STRANSKI AND D. WOLFF. *Research, Lond.*, **4**, 15–24 (*Jan.*, 1951).

Discusses the limits of validity of Langmuir's well-known equation relating evaporation and vapour pressure, and especially draws attention to the condensation coefficient and the possibility of its being strongly temperature-dependent in certain cases.

L. G. CARPENTER

536.423.4 : 534.222.2

3490. Condensation of water vapor in the shock tube below 150°K. P. WEGENER AND G. LUNDQUIST. Letter in *J. Appl. Phys.*, **22**, 233 (*Feb.*, 1951).

Condensation was observed during the expansion of moist air into a vacuum at a calculated temp. of 130°K—20 deg. below the threshold of Cwilong's tests [Abstr. 2134 (1947)]. Photoelectric detection of scattered light was used as a test for condensation.

536.424.1

3491. High-low quartz inversion up to 10,000 bars. H. S. YODER, JR. *Trans Amer. Geophys. Un.*, **31**, 827–35 (*Dec.*, 1950).

The high-low quartz inversion temperature has been measured up to 10 000 bars. The relation of change of the inversion temperature with pressure to earth-structure problems is discussed. Apparatus which has a working range up to 1 400°c and 10 000 bars is described. A.

536.46

3492. Flames: their structure and radiation. A. G. GAYDON. *Endeavour*, **10**, 17–21 (*Jan.*, 1951).

A brief review article (7 refs.) illustrated by 8 coloured photographs. The physical and chemical processes occurring in flames are discussed, particularly the formation of carbon and of CH and other radicals. The information given by spectral and positional analysis of the radiation from flames is also discussed.

536.46

3493. Flame propagation. II. The determination of fundamental burning velocities of hydrocarbons by a revised tube method. M. GERSTEIN, O. LEVINE AND E. L. WONG. *J. Amer. Chem. Soc.*, **73**, 418–22 (*Jan.*, 1951).

For Part I see Abstr. 2617 (1951). A method is described for the determination of fundamental rates of flame propagation in tubes. Data are presented for a variety of hydrocarbons including normal and branched alkanes, alkenes and alkynes as well as cyclohexane and benzene. The normal alkanes have a constant flame velocity except for methane which is slightly lower. Unsaturation increases the flame velocity in the order: alkanes < alkenes < alkynes. Branching reduces the flame velocity although the effect is small. A.

536.46

3494. Flame propagation. III. Theoretical consideration of the burning velocities of hydrocarbons. D. M. SIMON. *J. Amer. Chem. Soc.*, **73**, 422–5 (*Jan.*, 1951).

The maximum flame velocities for 35 hydrocarbons including *n*-alkanes, branched alkanes, *n*-alkenes, branched alkenes, alkenes, benzene and cyclohexane are shown to be consistent with the active particle diffusion theory of flame propagation. The rate constants calculated from the Tanford and Pease equation for all the hydrocarbons are the same: $1{\cdot}4 \pm 0{\cdot}1\times10^{11}$ cm³/mole/sec except for ethylene. The behaviour of ethylene is different from the other hydrocarbons. A.

536.46

3495. Ignition of methane-air mixtures by rapid compression. A. EGERTON, N. P. W. MOORE AND W. T. LYN. Letter in *Nature, Lond.*, **167**, 191–2 (*Feb.* 3, 1951).

Methane-air mixtures were ignited by adiabatic compression in a motored engine, the compression-ratio (C.R.) of which could be varied continuously between 4 : 1 and 28 : 1. Observation windows in the cylinder permitted observation of the flame, and the gas-pressure in the cylinder was recorded on a c.r. oscilloscope. Two distinct types of ignition were observed, characterized by a blue flame and a much more intense white flame. With a mixture 70% chemically correct, only blue flames occurred between C.R. 16·8 : 1 and 20·2 : 1, and only white flames at over 23·6 : 1; both types of flame were observed at C.R. between 20·2 : 1 and 23·6 : 1. The occurrence of two types of ignition under these experimental conditions does not, however, necessarily imply the existence of a cool-flame region in the combustion of methane. The occurrence of two alternative modes of ignition in propane and *n*-heptane has also been confirmed. A. SCHOFIELD

536.46 : 541.126

3496. The cool flame of methyl ethyl ketone. J. BARDWELL AND C. HINSHELWOOD. *Proc. Roy. Soc. A*, **205**, 375–90 (*Feb.* 22, 1951).

The regions of temperature and composition for which slow reaction, explosion, single and multiple cool flames respectively occur in the system gaseous butanone/oxygen have been determined. Factors affecting the frequency of cool flames have also been studied. The concentration of peroxides is shown to increase rapidly before the cool flame passes and to suffer a catastrophic decline as it does so. Aldehyde concentration does not follow a parallel course. The results are related to the general theory of hydrocarbon combustion, and the various phenomena are interpreted in terms of the view that the cool flame represents not the combustion of the primary reac-

tants, but the explosive decomposition of small quantities of accumulated intermediate peroxide. A.

536.48 : 534.22

3497. The velocity of second sound in liquid helium near the absolute zero. J. C. WARD AND J. WILKS. *Phil. Mag.*, **42**, 314–16 (*March*, 1951).

The expression $C/\sqrt{3}$ (C = vel. of ordinary sound) is derived directly from the phonon gas model without recourse to the 2-fluid theory.

536.531

3498. A rapid method for calculating and using platinum thermohm tables. R. A. BUERSCHAPER. *Rev. Sci. Instrum.*, **21**, 996–8 (*Dec.*, 1950).

A method is described whereby resistance-temperature tables can be calculated in a few hours using punched cards. The method is much simpler and quicker to use than the "platinum temperature" tables. An example is given for reducing resistance measurements to temperature and a method for checking bridge and thermohm drift with respect to the tables is proposed. A.

536.581.1

3499. A simple temperature-controlled laboratory furnace. R. S. BARNES. *J. Sci. Instrum.*, **28**, 89–92 (*March*, 1951).

A simple and robust laboratory furnace using an on/off method of control is described. The temperature-sensitive element (or "thermometer") is a Pt resistor which forms one part of the heater winding of the furnace, the other part, which is in series, being a Ni–Cr resistor. The simplicity of the furnace control derives from this combination of heater winding and thermometer, since such an arrangement calls for little amplification in the control circuit. The resistors of the heater circuit act as two arms of a Wheatstone bridge network which is balanced at a temperature determined only by the setting of the inductive ratio arms. The control circuit, which maintains the bridge in balance, consists of a thyratron-operated switch, the only amplification of the out-of-balance signal from the bridge being provided by an audio-frequency transformer with a tuned secondary. A.

536.75

3500. Maxwell's demon cannot operate: information and entropy. I. L. BRILLOUIN. *J. Appl. Phys.*, **22**, 334–7 (*March*, 1951).

In an enclosure at constant temperature, the radiation is that of a "black body," and the demon cannot see the molecules. Hence, he cannot operate the trap door and is unable to violate the second principle. If we introduce a source of light, the demon can see the molecules, but the over-all balance of entropy is positive. This leads to the consideration of a cycle: negentropy → information → negentropy, for Maxwell's demon as well as for the scientist in his laboratory. Boltzmann's constant k is shown to represent the smallest possible amount of negative entropy required in an observation. A.

536.75

3501. Physical entropy and information. II. L. BRILLOUIN. *J. Appl. Phys.*, **22**, 338–43 (*March*, 1951).

The laws of statistical thermodynamics are used for the definition of entropy, and it is shown that the definition of information can be reduced to a problem of Fermi–Dirac statistics or to a generalized Fermi statistics. With these definitions, the entropy of a certain message can be defined, and the information contained in the message can be directly connected with the decrease of entropy in the system. This definition leads directly to the formulae proposed by C. E. Shannon for the measure of information, and shows that Shannon's "entropy of information" corresponds to an equal amount of negative entropy in the physical system. The physical background of the whole method is discussed and found in agreement with previous discussions. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.221

3502. Measurement of contact potentials at the oil-water interface. J. T. DAVIES. Letter in *Nature, Lond.*, **167**, 193–4 (*Feb.* 3, 1951).

The contact potential of a petrol ether/water interface is measured by placing a vibrating gold disk (2 cm dia.) in the oil phase near to the interface. An amplitude of less than 0·01 cm causes little disturbance of the interface when the disk is at least 0·05 cm away and by means of a tuned amplifier potentials are measured with an accuracy of ±1 mV. Spreading a monolayer at the interface causes a permanent change in the potential as this oil phase has too high a specific resistance to allow ions to diffuse from the aqueous phase [see Abstr. 496 (1941)]. The method is applied to the study of "gaseous" films of some long-chain quaternary ions and the advantages of the oil/water system in other applications are indicated. J. IBALL

537.226 : 539.11

3503. Phenomenological equations of motion for simple ionic lattices. K. HUANG. *Rep. Brit. Elect. Res. Ass., No. L/T*239, 8 *pp.* (1950).

537.226.1

3504. The effective mass of a charged sphere moving slowly in a polarizable dielectric. H. PELZER. *Rep. Brit. Elect. Res. Ass., Ref. L/T*243, 8 *pp.* (1950).

Using, in the classical treatment of Abstr. 1894 (1949), a quantum mechanical estimate for the extension of the charge cloud of an electron in a NaCl crystal, the effective mass of electrons approaching zero velocity is found to be of the order of 400 electron masses. This result holds only for very small velocities. For thermal velocities the relations obtained previously still hold. A.

537.226.1

3505. Determination with centimetre waves of the dielectric constant of substances in the compact state from the dielectric constant of the powder. A. HELAINE, S. LE MONTAGNER AND J. LE BOT. *C.R. Acad. Sci., Paris*, **232**, 403–5 (*Jan.* 29, 1951) *In French.*

Measurements on powders of NaCl, etc., show that the dielectric constant of the compact solid can be calculated from that of the powder by the formula of Böttcher [*Rec. Trav. Chim. Pays-Bas*, **64**, 47 (1945)] to an accuracy of 10% and less accurately from the formulae of Bruggeman and of Lorentz. D. H. WHIFFEN

537.226.1

3506. On the principles of a null method for the determination of dielectric constants at ultra-high frequencies. M. BRUMA. *C.R. Acad. Sci., Paris*, **232**, 42–4 (*Jan.* 3, 1951) *In French.*

537.226.1

3507. On an arrangement permitting the determination of dielectric constants at ultra-high frequencies by a null method. M. BRUMA. *C.R. Acad. Sci., Paris*, **232**, 219–22 (*Jan.* 15, 1951) *In French.*

See Abstr. 3506 (1951).

537.226.1 : 537.311.35 : 541.182

3508. Electrical behaviour of non-aqueous disperse systems. A. DE WAELE AND R. W. RAINBIRD. Letter in *Nature, Lond.*, **167**, 244–5 (*Feb.* 10, 1951).

537.226.1 : 541.124

3509. A dielectric constant method of following the non-stationary state in polymerization. I. The theory of the method. C. M. BURRELL, T. G. MAJURY AND H. W. MELVILLE. *Proc. Roy. Soc. A*, **205**, 309–22 (*Feb.* 22, 1951).

For the investigation of the non-stationary state of chemical reactions and in particular polymerizations it is necessary to develop very sensitive means of recording small amounts of chemical change in short periods of time. For this purpose the change of dielectric constant accompanying reaction has been used. A recording capacity bridge working at 50 to 60 Mc/s has been constructed with a sensitivity of 1 part in 10^8 in capacity and a time resolution of 10^{-3} sec. This high sensitivity is achieved by the use of a new type of circuit incorporating a signal generator of special design; the capacity element in this bridge consists of the liquid reaction system enclosed in a silica cell. A.

537.226.1 : 541.124

3510. A dielectric constant method of following the non-stationary state in polymerization. II. The operation and performance of the instrument. T. G. MAJURY AND H. W. MELVILLE. *Proc. Roy. Soc. A*, **205**, 323–35 (*Feb.* 22, 1951).

The operation of the instrument described in Part I (preceding Abstr.) and the interpretation of the results in terms of the amounts of polymerization that occur as a result of photochemical initiation are described. The sensitivity has been independently checked and found to agree with calculation. The usefulness of the instrument is governed by the inherent drift, and, in this application, by the loss of heat from the reaction mixture. These factors impose an upper limit of about 1 min for the useful time of observation. A.

537.226.1 : 541.124

3511. A dielectric constant method of following the non-stationary state in polymerization. III. The determination of rates of polymerization and of radical lifetimes. T. G. MAJURY AND H. W. MELVILLE. *Proc. Roy. Soc. A*, **205**, 496–516 (*March* 7, 1951).

See Abstr. 3510 (1951) for Part II. This method has been applied to the polymerization of styrene, vinyl acetate, methyl acrylate and butyl acrylate, initiated both by continuous illumination and by use of a flash discharge tube. It has proved possible to delineate the course of the non-stationary state with continuous illumination and also to delineate the decay of radical concentration when illumination ceases. With the flash the decay of radical concentration can be delineated. The analysis of these records gives the values of the lifetimes of the radicals and the corresponding rates of polymerization. These lifetimes agree reasonably with those determined by other methods. The general application of this method and of the instrument to other problems in physical chemistry is indicated. A.

537.226.2

3512. The dielectric constant of barium titanate. M. KORNETZKI. *Z. Phys.*, **128** (*No.* 5) 605–13 (1950) *In German.*

A known formula for the permeability of ferromagnetic materials on the basis of the Bloch barrier displacement theory is used by analogy for the calculation of an experimental value of the dielectric constant ε_a of polycrystalline $BaTiO_3$ at room temperature. The dielectric constant ε_0 was calculated from the saturation polarization, the elastic moduli, and the electrostriction, using single-crystal values and an axial ratio c/a of 1·01 during electrostriction. This gave $\varepsilon_a \simeq \varepsilon_0$. To find the cause of the discrepancy the electrostriction in polycrystalline $BaTiO_3$ was measured, the greatest value being $1{\cdot}1 \times 10^{-3}$ coul. cm^{-2} for a field strength of 8–10 kV cm^{-1}. Using this value together with the measured saturation polarization of polycrystalline $BaTiO_3$ the dielectric constant was found to be $\simeq 700\,\varepsilon_0$. The differences in electrostriction and saturation polarization for single-crystal and polycrystalline $BaTiO_3$ are briefly discussed. C. A. HOGARTH

537.226.3

3513. Absorption in the ultrahertzian region and the hydroxyl bond: water of crystallization and water of adsorption. M. FREYMANN AND R. FREYMANN. *C.R. Acad. Sci., Paris*, **232**, 401–3 (*Jan.* 29, 1951) *In French.*

Dielectric loss at 3·15 cm is taken as a measure of the "free" or "liquid-like" water in a solid. $NaBr \cdot 2H_2O$, $CuSO_4 \cdot 5H_2O$, $NiSO_4 \cdot 7H_2O$, $UO_2(NO_3)_2 \cdot 6H_2O$, etc., all have $\varepsilon'' < 0{\cdot}04$ and no free water. H_2O adsorbed on SiO_2 and Al_2O_3 gives considerable loss, though less than sugar or NaCl with the same percentage of water. $Al(OH)_3$ and dehydrated forms are loss-less but rehydration of the same material introduces a loss. D. H. WHIFFEN

537.226.31

3514. Loss-angle measurements on high dielectric-constant materials. E. LEDINEGG AND P. URBAN. *Acta. Phys. Austriaca*, **4** (*No.* 2–3) 197–212 (1950) *In German.*

In general the resonant frequency of a cavity resonator is changed by the introduction of a dielectric. A mathematical study of the subject leads to the conclusion that with a given cylindrical cavity a dielectric slab placed therein will not alter the resonant frequency or the field distribution provided it has a certain "critical" thickness. This result is applied to the experimental determination of the loss angle (tan δ) of dielectric. The method is useful in practice for accurate measurements when the test material has a high dielectric constant and relatively small loss angle, since other methods are not suitable for such

cases. Some experimental results on trolitul are presented in confirmation; although this material has a low dielectric constant this is compensated by its extremely low power factor. The tests were made with a wavelength of 14 cm. A. M. THOMAS

537.226.8

3515. The change of the electrical properties of calcite in relation to its temperature luminescence. F. I. KOLOMOĬTSEV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 2) 185–8 (1950) *In Russian.*

Measurements were made of the current through a specimen of calcite and of the charge accumulated through polarization at temperatures from 0 to 340°C under a constant applied voltage. It is found that electron transitions and the formation of electronic conduction are more important than was thought. The formation of highly polarized layers can provide, in certain dielectrics, a mechanism for the removal of electrons from bound levels. By draining the electron traps in calcite it is possible to elucidate the dependence of dielectric susceptibility on temperature and field. A. L. MACKAY

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.31 : 538.632

3516. Hall coefficient and resistivity of evaporated bismuth layers. W. F. LEVERTON AND A. J. DEKKER. Letter in *Phys. Rev.*, **81**, 156 (*Jan.* 1, 1951).

537.311.32 : 621.3.011.2 : 621.315.612.4

3517. Discontinuities in the conductivity of $BaTiO_3$. N. A. TOLSTOI. *J. Tech. Phys., USSR*, **20**, 970–4 (*Aug.*, 1950) *In Russian.*

Characteristic discontinuities are of two types, i.e. one connected with surface phenomena (rapid leaps), the other with volume phenomena (π-type leaps). The high permittivity of $BaTiO_3$ (1 000–2 000) raised doubts whether or not it constituted a ferroelectric at all. A smoothly increasing field applied to an artificial single-crystal produces a discontinuous polarization. The macroscopic domains of the crystal change orientation at certain field values corresponding to certain energy barriers to be overcome. At temperatures above the Curie point these phenomena disappear. The analogy with the discontinuities of the magnetic polarization in ferromagnetics caused these phenomena to be called "electric Barkhausen discontinuities." A point of particular interest is that $BaTiO_3$ is a polycrystalline substance. B. F. KRAUS (R)

537.311.33

3518. Lattice defect phenomena and diffusion processes in semi-conducting mixed phases. K. HAUFFE. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 201–10 (1950) *In German.*

An extension of the lattice-defect theory of Wagner and Schottky and application to the changes in conductivity of mixed metal oxides through addition of cations with higher and lower charge. Experimental verification of the theoretical results. E. P. WOHLFARTH

537.311.33

3519. On the mechanism of impurity band conduction in semiconductors. C. ERGINSOY. Letter in *Phys. Rev.*, **80**, 1104–5 (*Dec.* 15, 1950).

A model is proposed in which an impurity band is formed by the interactions of excited impurity states at high concentrations, and this will explain the anomalous low-temperature behaviour of Hall effect and electrical conductivity for SiC, and probably for Ge. C. A. HOGARTH

537.311.33

3520. Mobilities of electrons in high electric fields. E. J. RYDER AND W. SHOCKLEY. Letter in *Phys. Rev.*, **81**, 139–40 (*Jan.* 1, 1951).

Steady-state changes in the mobility of electrons in a Ge sample have been observed, hole emission being excluded experimentally up to fields of 2×10^4 V/cm by special precautions. The mobility was found to be constant up to fields of 6×10 V/cm, and to vary inversely as the field thereafter. A pulse technique was used. P. T. LANDSBERG

537.311.33

3521. The inverse voltage characteristic of a point contact on *n*-type germanium. L. P. HUNTER. Letter in *Phys. Rev.*, **81**, 151–2 (*Jan.* 1, 1951).

A qualitative picture of the effect of self-heating on the inverse voltage characteristic of a Ge point contact is given, particularly for the high-voltage breakdown and negative resistance regions. It is assumed (i) that the isothermal *V–I* characteristics are straight lines, (ii) that Newton's law of cooling holds, and (iii) that the conductivity of the isothermal characteristic shows a thermal activation energy of about 1 eV. The isothermal characteristics are drawn as straight lines from the origin for various ambient temperatures, and on the same diagram hyperbolae of constant power corresponding to the same temperature increments. The points of intersection of corresponding curves then yield the well-known inverse d.c. characteristic. The relation of this curve to that given by Aigrain's theory [Abstr. 4084 (1950)] is discussed. C. A. HOGARTH

537.311.33

3522. Pulse measurement of the inverse voltage characteristic of germanium point contacts. A. I. BENNETT AND L. P. HUNTER. Letter in *Phys. Rev.*, **81**, 152 (*Jan.* 1, 1951).

By the use of 0·5 μsec pulses to eliminate heating effects (see preceding Abstr.), the inverse characteristics of Ge single-crystal point contact rectifiers are found to be straight lines out to voltages at least twice as high as the normal breakdown values. C. A. HOGARTH

537.311.33

3523. Effect of heat treatment on the electrical properties of germanium. H. C. THEUERER AND J. H. SCAFF. *J. Metals*, Sect. 1, **191**, 59–63 (*Jan.*, 1951).

Since both the mechanism and the magnitude of the electrical conductivity depend on the kind and quantity of impurities present, the conductivity is usually adjusted by first carefully purifying the Ge, and then, by standard alloying procedures, adding the elements desired. The elements usually added are

from the 3rd or 5th periodic groups depending upon whether *p*- or *n*-type Ge is desired. It has also been found possible to produce conversion from *n* to *p* type by heat treatment. Data for the conversion and the associated changes in resistivity are given and the results are interpreted in terms of changes in the donor-acceptor balance. METROPOLITAN-VICKERS

537.311.33

3524. Electrical properties of grey tin. G. BUSCH, J. WIELAND AND H. ZOLLER. *Helv. Phys. Acta*, **24** (*No.* 1) 49–62 (1951) *In German.*

Grey Sn of high purity was prepared by prolonged cooling of spectroscopically pure metallic Sn and numerous alloys were made by adding small amounts of aluminium. The conductivity was determined by measuring the *Q*-factor of a coil containing a core of grey Sn powder at frequencies up to 30 Mc/s. With decreasing temperature σ decreased according to an exponential law. Intrinsic conductivity with an activation energy of about 0·1 eV was found down to − 100°C. At 0°C σ reached a value of $5\times10^3\ \Omega^{-1}$ cm^{-1}. At low temperatures σ strongly increased with increasing amount of added impurities. Hall effect and the change of resistivity in a magnetic field were measured by conventional d.c. methods. Remarkably high changes of the resistivity in magnetic fields were observed. The experiments show that grey Sn is a semiconductor of high electrical conductivity with properties very similar to those of Si and Ge. A.

537.311.33 : 538.63

3525. Electrical properties of grey tin. A. I. BLUM AND N. A. GORYUNOVA. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 3) 367–70 (1950) *In Russian.*

Gives the results of measurements of (1) electrical conductivity $\sigma = 28\ ohm^{-1}\,cm^{-1}$ at 20°C and $16{\cdot}3\ ohm^{-1}\,cm^{-1}$ at − 195°C; (2) thermo-electromotive force $\alpha = -10\ \mu V$ at 10°C and $+4{\cdot}6\ \mu V$ at − 140°C; (3) Hall effect $R = -3{\cdot}2$ (CGSM units) at 20°C and − 120 at − 195°C. Grey tin should be classed as semiconductor. F. LACHMAN

537.311.33 : 538.63 : 548.0

3526. On the electro-magnetic properties of single crystals of tellurium. I. Electric resistance, Hall effect, magneto-resistance and thermo-electric power. T. FUKUROI, S. TANUMA AND S. TOBISAWA. *Sci. Rep. Res. Inst. Tohuko Univ., Ser. A*, **1**, 373–86 (*Dec.*, 1949).

The resistivity, the Hall, the magneto-resistance and the Seebeck effects were investigated with highly purified single crystals from -190° to $+300^{\circ}$C. The crystals were found to be a P-type extrinsic semiconductor at low temperatures, while an intrinsic conduction supersedes it above ice point. The energy gap between the conduction band and the normally filled band is estimated at 0·34 eV. In terms of the electric and the galvanomagnetic data, the concentrations, the mobilities, the effective masses, and the mean free paths of positive holes and electrons are expressed as functions of temperature. The thermo-electric data are also compatible with the above results. A.

537.311.33 : 538.632

3527. The Hall coefficient of semiconductors. H. JONES. Letter in *Phys. Rev.*, **81**, 149 (*Jan.* 1, 1951).

537.311.33 : 666.2 : 621.315.59

3528. Surface conductivity of lead silicate glass after hydrogen treatment. K. B. BLODGETT. *J. Amer. Ceram. Soc.*, **34**, 14–27 (*Jan.*, 1951).

The surface layer of a lead silicate glass containing 61% PbO became conducting after certain prescribed hydrogen treatments. The layer was 50–100 Å thick. The specific resistance was 800 Ω-cm, or more depending on the hydrogen treatment. The ratio of hot-to-cold resistance was constant for various values of cold resistance, showing that the conducting substance was a semiconductor. A coating of this glass was applied to porcelain by powdering, spraying, and firing the glass. METROPOLITAN-VICKERS

537.311.37 : 537.523

3529. Turbulence in gaseous conductors. K. G. EMELÉUS. *Proc. Phys. Soc., Lond. B*, **64**, 166–9 (*Jan.*, 1951).

It is suggested that turbulent flow of electricity may occur under certain conditions in an ionized gas, even if the gas is not in a magnetic field. Examples are given of high and low frequency disturbances which may be of this character. The difficulties in the way of developing a quantitative theory, and the possibility of the coupling of electromagnetic and hydromechanical phenomena, are pointed out. A.

537.312.5 : 538.221

Superficial photoelectric effect in ferromagnetics. *See Abstr.* 3629

537.312.6

3530. Measurements on the electrical resistivity of thin iron films at liquid helium temperatures. R. LAMBEIR, A. VAN ITTERBEEK AND G. J. VAN DEN BERG. *Physica*, **16**, 907–14 (*Dec.*, 1950).

Measurements have been made on the resistivity of thin Fe films (30–200 mμ thick) as a function of the measuring current (0–500 μA) at liquid He temperatures. We found at the lowest temperatures a very steep decrease of the resistance as a function of current is found and this decrease is very sensitive to the temperature and is connected to the temperature coefficient of the film in question. This temperature coefficient depends on the kind of gas (Ne or H_2) used during the sputtering. The phenomenon seems to be connected with the fact that thin films are composed of small crystals separated by very narrow channels. A.

537.312.6

3531. The electrical resistance of gold, silver and copper at low temperatures. E. MENDOZA AND J. G. THOMAS. *Phil. Mag.*, **42**, 291–303 (*March*, 1951).

A brief review of published papers on the subject of electrical resistance at very low temperatures shows that several metals exhibit a feature which has not yet been explained theoretically, namely that the resistance goes through a minimum value as the temperature decreases, whereas present theories indicate that it should remain constant. An apparatus is described for measuring electrical resistance below 1°K; by means of its use, the effect was confirmed in Au and Ag and also found in Cu. There was no tendency for the curves to flatten off even at the lowest temperatures. The Au behaved in magneto-resistance experiments as if it contained < 1 part in 10^6 of ferromagnetic

impurity. Slight anomalies in the shapes of some of the curves seem also to exist. A.

537.312.62

3532. The perfect diamagnetism of free electrons with application to superconductivity. M. F. M. OSBORNE. Letter in *Phys. Rev.*, **81**, 147–8 (*Jan.* 1, 1951).

A report of calculations on the behaviour of a completely degenerate free electron gas in a finite box, assuming (1) a uniform magnetic field, (2) a magnetic field decaying exponentially from the surface. It is claimed that in case (1) there is almost perfect diamagnetism up to a critical field and then a triple-valued transition to a non-diamagnetic state. Below the critical field, case (2) describes the penetration field. R. B. DINGLE

537.312.62 : 537.32

3533. Thermoelectromotive force of a superconductor *versus* the same metal in the non-superconductive state. M. C. STEELE. *Phys. Rev.*, **81**, 262–7 (*Jan.* 15, 1951).

Measurements have been made for Pb, Sn, In and Tl. The technique used differed in several respects from that employed by previous workers. Results are discussed in light of existing theory. It is found that the data obtained are in good agreement with a relation derived from Fermi–Dirac statistics and the assumption that the Thomson coefficient of a superconductor is zero. A.

537.363 : 541.182

3534. The influence of sugars on the electro-kinetic potential and interfacial tension between aqueous solutions and certain organic compounds. I. The electrophoretic behaviour of organic dispersions. II. The interfacial tension between aqueous sugar solutions and (1) a liquid paraffin and (2) *n*-undecyl alcohol, at 25°C. H. W. DOUGLAS. *Trans Faraday Soc.*, **46**, 1082–95 (*Dec.*, 1950).

ELECTRIC DISCHARGES 537.52

537.52

3535. A survey of recent advances in discharge physics. A. VON ENGEL. *Nuovo Cim.*, **8**, 42–53 (*Jan.*, 1951). 80 references.

537.523

3536. A study of a high-current toroidal ring discharge. A. A. WARE. *Philos. Trans A*, **243** (*No.* 863) 197–220 (1951).

A toroidal ring discharge has been studied in which the exciting primary is a metal coating on the outside of the torus. The waveforms of the currents and electric fields in the gas have been obtained, and the light from the discharge has been studied spectroscopically and with a photo-multiplier, the gases used being H and A. Very large currents flow in the gas with peak amplitudes greater than 10^4 A. The current is in phase with the electric field, the exciting frequency being 150 kc/s. Photographs of the discharge show a marked "pinch" effect in A. The method of Craggs and Hopwood [Abstr. 3207 (1947)] has been applied to determine the ion concentrations from the broadening of the Balmer lines. Peak ion concentrations occur which are greater than the molecular concentrations. High-frequency oscillations (1 to 5 Mc/s) occur in the gas and are thought to be plasma-ion oscillations. A.

537.523.4 : 621.3.015.5 : 621.315.618.2

3537. The mechanism of breakdown of air at ultra high frequencies. R. COOPER. *Rep. Brit. Elect. Res. Ass., Ref. L/T*189, 13 *pp.* (1948).

Describes progress made in the development of a cloud chamber and its associated equipment for the study of the mechanism of sparks occurring at frequencies greater than 10^9 c/s. During the course of the work an unusual form of discharge was observed in the cavity resonator used for the spark gap. A spectroscopic examination of the light emitted by the discharge has been made. A cloud chamber is described constructed for studying the mechanism of sparks in certain unidirectional fields. A.

537.523.4/.527.4 : 535.243/.247.4

3538. A new photographic technique for studying time processes in impulse discharges. W. GÖING. *Naturwissenschaften*, **37** (*No.* 24) 558–9 (1950) *In German.*

This letter describes a method of obtaining photographs and spectrophotographs of impulse sparks ($\sim 10^{-5}$ sec) at various times (in stages of 5×10^{-7} sec) during their development. F. LLEWELLYN JONES

537.523.74

3539. Pinch effect oscillations in a high current toroidal ring discharge. S. W. COUSINS AND A. A. WARE. *Proc. Phys. Soc., Lond. B*, **64**, 159–66 (*Feb.*, 1951).

A toroidal ring discharge with currents greater than 10^4 A has been studied with a rotating mirror camera. The photographs show a lateral oscillation of the discharge, which consists of an alternate contraction and expansion of the current filament. The frequency of the oscillations increases with decrease in pressure or increase in voltage and $\propto$ (atomic weight of the gas)$^{-\frac{1}{2}}$. The oscillations are thought to be due to plasma ion waves, which are excited by the large "pinch" effect forces. A.

537.525

3540. On a technique for measuring the electronic velocity-distribution function in a gas-discharge. YU. M. KAGAN, V. L. FEDOROV, G. M. MALYSHEV AND L. A. GAVALLAS. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 215–17 (1951) *In Russian.*

Measurement of the distribution of electronic velocities in a gas discharge by means of probes involves the evaluation of d^2i/dV^2, where i is the probe current and V the probe potential. The essential feature of the technique here described is that a saw-toothed periodic voltage V is applied to the probe, so that d^2i/dV^2 is proportional to d^2i/dt^2 (where t is time); the value of d^2i/dt^2 is formed in an orthodox differentiating circuit, and is displayed on a cathode-ray oscillograph directly as a function of V. The periodic form of V leads to a steady display on the c.r. tube, which is convenient for visual examination and photography. Qualitative results are given for a Hg-vapour discharge carrying 100 mA at 13°C. The presence of a group of fast electrons in the

neighbourhood of the cathode is demonstrated; these fast electrons are not present in the main body of the discharge away from the cathode. A. SCHOFIELD

537.525 : 539.153

3541. Decay of the hydrogen discharge. J. M. RICHARDSON AND R. B. HOLT. Letter in *Phys. Rev.*, **81**, 153–4 (*Jan.* 1, 1951).

The variation of the electron density with time, following the passage of a current through hydrogen (1–20 mm Hg press.) has been studied. The coefficient for the two-body recombination process was found to be (7–20 mm Hg press.) $6{\cdot}2\times10^{-6}$ cm^3/electron-sec. At the lower pressures ambipolar diffusion predominates and the diffusion coefficient × pressure (Dap) = 600 cm^2-mm Hg/sec (1–3 mm Hg press.). Decay mechanisms, excitation processes, etc., are briefly discussed. J. D. CRAGGS

537.525.4

3542. On the different regimes of gaseous electrical discharges. M. BAYET. *C.R. Acad. Sci., Paris*, **231**, 1442–4 (*Dec.* 18, 1950) *In French.*

Discusses the breakdown-voltage/pressure curves for pressures of 0·2–1·4 mm Hg in hydrogen for h.f. (λ = 30–189 m), with special reference to the Paschen minimum. J. D. CRAGGS

537.525.5 : 537.525.9

3543. Plasma-electron oscillations. T. R. NEILL AND K. G. EMELÉUS. *Proc. Roy. Irish Acad.*, **53** (*No.* 13) 197–22 (*Jan.*, 1951).

A detailed study of the oscillations picked up by probes in the low-pressure hot-cathode discharge in Hg at $\sim 10^{-3}$ mm Hg pressure. The oscillation patterns in the plasma were found with movable probes (the oscillation frequencies were $\sim$ 150 Mc/s), and a considerable part of the paper is devoted to a study of these patterns. It was found that the oscillation frequencies agreed closely with those calculated from the electron concentrations (determined with probes in the normal way) using the Tonks–Langmuir theory. Oscillation maintenance mechanisms are discussed comprehensively. J. D. CRAGGS

537.525.72

3544. On slow electric waves in gasfilled metal tubes. W. O. SCHUMANN. *Z. Phys.*, **128** (*No.* 5) 629–34 (1950) *In German.*

The existence of h.f. waves of low diffusion velocity in metal tubes filled with rarefied gas is attributed to surface waves along the plasma boundary surface. [See S. B., *Bayer Akad. Wiss.*, S255 (1948)]. The plasma natural frequency ω_0 appears between $\omega_0 \simeq \omega$ and $\omega_0 \simeq \sqrt{2}\omega$ for regions in which "slow" electric waves are possible. Z. F. WOJNAR

537.525.8

3545. Noise temperature of a d.c. gas discharge plasma. S. KOJIMA AND K. TAKAYAMA. Letter in *Phys. Rev.*, **80**, 907 (*Dec.* 1, 1950).

Observations were made in glow discharge tubes containing A (1–3 mm Hg press.). The noise temp. (T_n) defined by the relation $\overline{e^2} = 4kT_nR$, where R is the resistance between the pick-up probe (at which the noise voltage appeared) and the anode of the discharge tube, was of the same order as, but greater than, T_e (the electron temp. as measured with probe techniques). J. D. CRAGGS

537.525.8

3546. Method for the variation of the activation conditions of organic substances in the glow discharge. H. SCHÜLER AND L. REINEBECK. *Z. Naturforsch.*, **5a**, 657–60 (*Dec.*, 1950) *In German.*

The electron velocity distribution in the positive region of the glow discharge is varied by the introduction of such gases as He, Ne, Ar, H_2 and N_2, and thereby enables the activation conditions of organic substances, e.g. benzene, aldehydes, ketones (especially acetone) to be determined. 11 references. H. H. HODGSON

537.525.8

3547. Oscillatory phenomena in direct current glow discharges. T. DONAHUE AND G. H. DIEKE. *Phys. Rev.*, **81**, 248–61 (*Jan.* 15, 1951).

In glow discharges having a positive column with a constant e.m.f. and a series resistance, oscillations usually are observed in tube voltage, current and light intensity. While current and voltage oscillations represent a modulation of only a few per cent, the intensity decreases to zero between maxima in the positive column, but there is an appreciable steady component near the cathode. The intensity maxima move as positive striations toward the cathode, or as negative striations with a much higher speed toward the anode. Where positive and negative striations meet they stop for times up to 100 μsec. The oscillations are often very stable and repeat themselves without change for hours. Often several modes exist and the discharge moves back and forth between them and appears unstable. The data presented in this paper were obtained chiefly from A discharges, although similar phenomena occur in most other gases over a great range of pressure and current. A discussion of the mechanism producing the phenomena is given. A.

537.525.8/.9

3548. On the theory of double layers in low-pressure gas discharges. T. WASSERRAB. *Z. Phys.*, **128** (*No.* 5) 575–85 (1950) *In German.*

Discusses in some detail the physics of double layers (regions in which a negative space charge merges into a positive space charge) in l.p. gaseous discharges. Special reference to the earlier work of Langmuir and Tonks is made, and the effect of the partial pressure of neutral gas is particularly stressed. J. D. CRAGGS

537.525.9

3549. A contribution to the determination of the electron density in a gas discharge at low pressure. M. FIEBICH. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 170–9 (1950) *In German.*

The influence of the potential of the tubes, through which small wire probes are introduced to determine the density of the plasma electrons by Langmuir's method, is determined. It is shown that the space charge layer which forms on these tubes leads to false results for the electron density, and a new method is suggested which eliminates this error. J. HUGHES

537.528 : 621.3.015.51 : 621.315.61

3550. Formation of "bridges" in suspensions of conductors or semi-conductors in dielectrics. I. Conducting-bridge formation of aluminium in vaseline oil. L. G.

GINDIN, YA. I. FRENKEL AND O. A. SHPANSKAYA. *J. Tech. Phys., USSR*, **20**, 937–43 (*Aug.*, 1950) *In Russian.*

Investigation of the behaviour in strong electric fields of low concentration suspensions of Al in vaseline oil. It was found that after a certain critical value of the field strength the electric breakdown of the suspension occurs, i.e. conversion from a dielectric to a metallic conductor, owing to formation of bridges of Al particles. The curve of the influence of $E_{crit.}$ on dispersion of Al particles was almost a straight line. If for linear particle dimension λ, $E_{crit.} =$ 4 000 V/cm, size reduction to $\lambda/5$ brings $E_{crit.}$ to 13 000 V/cm. The critical Al concentration in the oil at which bridge formation is possible rises with its dispersion. If for particle size λ the limiting concentration = 0·005%, it is 0·05% for $\lambda/5$. It is interesting that for $E \gg E_{crit.}$ a weak (0·05%) concentration remains a dielectric. This is due to intense turbulence of suspension between electrodes. Variation of electrode distance from 0·5 to 3·5 mm does not alter $E_{crit.}$ At distance > 3·5 mm bridges were not completed. There is a certain "induction period." Detection of bridge formation is by fall of E from ~ 4 000 V/cm to ~ 1 V/cm and interruption of particle movement. B. F. KRAUS

X-RAYS 537.531

537.531 : 535.33

3551. The X-ray spectrum produced by 322-MeV electrons striking a platinum target. W. M. POWELL, W. HARTSOUGH AND M. HILL. *Phys. Rev.*, **81**, 213–18 (*Jan.* 15, 1951).

The differential energy spectrum of the photons produced by 322-MeV electrons striking a 20-mil Pt target was measured by observing the energy of 3 467 pairs produced in a 1-mil thick Pb foil in a Wilson cloud chamber in a magnetic field of 10 000 gauss. The spectrum is found to agree with that predicted by the Bethe–Heitler bremsstrahlung theory using a Thomas–Fermi model with suitable corrections for the thickness of the target. The energy of the 322-MeV electrons was determined by the spectrum of the photons observed in this experiment. A.

537.531 : 535.343.2

3552. The M_{IV} and M_V absorption edges of ^{68}Er. E. A. STEWARDSON AND P. A. LEE. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 318–19 (*March*, 1951).

Edges were measured at 8 583 and 8 829 x v. A thick absorption film was used, and thus confirmation is provided for Rule's suggestion [Abstr. 1084 (1946)] that Lindberg [*Nova Acta Soc. Sci. Uppsala*, **7** (*No.* 7) 68 (1931)] used too thin a film in his apparent observation of twin absorption lines at the expected M_V position.

537.531 : 535.343.2 : 548.732.2

3553. X-ray absorption in crystals set at the Bragg angle. H. N. CAMPBELL. Note in *Acta Cryst.*, **4**, 180–1 (*March*, 1951).

A crystal set at the Bragg angle should show a higher apparent absorption coefficient than when off the Bragg angle; preliminary experiments fail to confirm this effect. No extinction effect is observed; in fact there is an increase in the transmitted beam about equal to the intensity of the reflected beam. The best explanation is that when the Laue conditions are satisfied in a perfect crystal there is a resonance effect which decreases the effective absorption rather than increasing it as previously supposed.

537.531 : 615.849

3554. International recommendations on radiological units. *Brit. J. Radiol.*, **24**, 54–6 (*Jan.*, 1951). Also in *Nucleonics*, **8**, 28–30 (*Jan.*, 1951).

Sixth International Congress of Radiology (London, 1950). The satisfactory expression of the biological effect of an ionizing radiation (energy absorbed per unit mass) is not easily made in practice by calorimetric measurements. Ionization in a gas is related to the energy absorbed, when factors W, the energy expended per ion pair formed in the gas, and s, the stopping power relative to the gas, of the material irradiated are known. Values of W, s, and variables characteristic of the radiations and material irradiated, are to be prepared and continually reviewed. The roentgen, unchanged in definition, should remain as a unit for radiation excited up to 3 MeV. Other multiple-roentgen units are not recognized. The curie is redefined as a universal unit of radioactivity. Values for γ-ray emission from radioactive isotopes, expressed as r/mc. hr at 1 cm from a point source, will be prepared. Nomenclature concerning tissue and air dosage, quantity and quality of X-rays, and fractionation of treatment, remains unchanged. Conditions and specifications for patients undergoing radium treatment are advised. Use and calibration of instruments as primary standards or for routine measurements of X-rays and γ-rays are outlined. For previous account see Abstr. 2725 (1951). See also Abstr. 4013 (1951). D. V. MABBS

537.531.08 : 539.16.08

3555. The measurement of X and gamma radiation over a wide energy range. L. S. TAYLOR. *Brit. J. Radiol.*, **24**, 67–81 (*Feb.*, 1951).

The advent of the water-cooled Be-window X-ray tubes having a high-intensity output ranging from 10^5 to 2×10^6 r/min has necessitated for its measurement a revised design of the Bureau of Standards special guarded field chamber. Reduction of the limiting diaphragm from 8 mm to 0·5 mm results in a decrease in the field strength from 4 000 volt/cm to 200 volt/cm to attain saturation. Extension of the design to 500 kV measures 4 ft × 4 ft × 8 ft and weighs 8 tons. The problem of measuring the radiation from the betatron is not yet solved. A high-intensity ion tube is under construction which by means of the H–Li reaction will provide a monochromatic source of 17-MeV radiation to calibrate the instruments. The effects of under-saturation in thimble chambers are discussed and in an attempt to overcome this difficulty the so-called vacuum chamber is being investigated. As a result of the large growth of the radiation-instrument business calibrated secondary standards are now provided. Scintillation counters have been found reliable over wide ranges. For photographic sensitometry the dosage response of nearly every commercial emulsion on the American

market has been measured. The review concludes with a survey of miscellaneous measurement problems, such as β-rays from Sr 90, radiation from the cavity tube, betatrons and other pulsed sources and of the electron beams from betatrons operating in the 30- to 180-MeV range. T. A. CHALMERS

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533 : 621.384.6

3556. A note on resonance damping, at injection, in betatrons and synchrotrons. S. E. BARDEN. *Proc. Phys. Soc., Lond. B*, **64**, 85–6 (*Jan.*, 1951).

Resonance damping of "free" radial oscillations, brought into action by the creation of favourable inhomogeneities by the large currents circulating at injection, is put forward as a possible mechanism explaining why electrons do not collide with the injector structure on subsequent revolutions. A theoretical analysis is given.

537.533.72

3557. Results of numerical calculations of the trajectories of electric corpuscles in the field of an elementary magnet. VII. Trajectories through the origin; supplementary beams. C. STØRMER. *Skr. Norske Vidensk. Akad., Oslo, I. Mat.-Nat. Kl. No.* 2, 75 *pp.* (1949).

Continuation of work published earlier in the same journal (1947, Paper 1). The results are given in 6- or 5-figure tables.

537.533.72

3558. An analytical approximation of axially symmetric potential fields with cylindrical equipotentials. F. LENZ. *Ann. Phys., Lpz.*, **8** (*No.* 3–4) 124–8 (1950) *In German.*

The method, utilizing the zeros of the Bessel function of zero order, is explained, and illustrated by an application to the field distribution near the poles of an electromagnet. The formulae are used, in the case of a weak magnetic lens, to calculate the optical constants. L. S. GODDARD

537.533.72

3559. "Schlieren" optics in the electron microscope. H. KÖNIG. *Naturwissenschaften*, **37** (*No.* 21) 486–90 (1950) *In German.*

A general description of the electron optical analogue of the "Schlieren" method. M. R. HOPKINS

537.533.72

3560. The correction of the spherical aberration of electron lenses using a correcting foil element. U. F. GIANOLA. Letter in *Proc. Phys. Soc., Lond. B*, **63**, 1037–9 (*Dec.*, 1950).

The negative spherical aberration produced by a pair of plane parallel conducting foils suitably placed in an electron lens system is described and analysed mathematically. The use of such foils as correcting elements and the problems arising in the design of a foil-corrected lens are briefly discussed.

M. R. HOPKINS

537.533.72

3561. Beta-ray spectroscopes. E. PERSICO AND C. GEOFFRION. *Rev. Sci. Instrum.*, **21**, 945–70 (*Dec.*, 1950).

A review of the various types of beta-ray spectrographs and spectrometers. The principal theoretical results as to the resolving power and luminosity attainable under various conditions are briefly related. Finally the construction and performance data of a number of instruments described in the literature are collected, and compared by means of a graphical representation. A.

537.533.72

3562. A double thin lens beta-ray spectrometer. C. M. VAN ATTA, S. D. WARSHAW, J. J. L. CHEN AND S. I. TAIMUTY. *Rev. Sci. Instrum.*, **21**, 985–90 (*Dec.*, 1950).

A detailed investigation of the separate distortions introduced by chamber misalignment, internal scattering, charged source and poor resolution has been made, and the results are presented qualitatively. An alignment procedure is presented, and also the arrangement of baffles to minimize scattering. A.

537.533.72

3563. Beta-ray spectrographs with electron lenses. (Unified theory of classical types. A new apparatus). II. P. GRIVET. *J. Phys. Radium*, **12**, 1–14 (*Jan.*, 1951) *In French.*

The author's theory [Abstr. 2734 (1951)] is applied to a spectrograph with a uniform field, to one with a single short winding, to the spectrograph of K. Siegbahn and that of Siegbahn and Slatis; and to a double spectrograph. J. THEWLIS

537.533.72

3564. Potential and field of a particular type of cylindrical lens. E. DURAND. *C.R. Acad. Sci., Paris*, **232**, 314–16 (*Jan.* 22, 1951) *In French.*

Considers theoretically the case of an electrostatic lens composed of two parallel half-infinite planes situated between two infinite planes parallel to the first two and at a different potential. Equipotential surfaces are drawn. J. THEWLIS

537.533.72 : 535.767

3565. Stereoscopy with the electron microscope. F. HEISE. *Optik*, **7** (*No.* 4–6) 256–60 (1950) *In German.*

Illustrates a number of stereo-electronmicrographs obtained by the use of a stereo electron microscope in which the stereoscopic image is obtained in one exposure. The incident beam is split into two by a pair of diaphragms. A second pair is introduced near the focal plane of the objective. The specimen holder is a rolled metal grid with such small gaps that the image from one source falls within the shadow of the specimen holder given by the other. By a simple projection device separate left- and right-hand prints may be obtained. J. THEWLIS

537.533.72 : 537.531 : 621.385.833 : 621.386.1

3566. An electrostatic focusing system and its application to a fine focus X-ray tube. W. EHRENBERG AND W. E. SPEAR. *Proc. Phys. Soc., Lond. B*, **64**, 67–75 (*Jan.*, 1951).

The description is given of an electrostatic focusing system by which electrons emitted from the tip of a hairpin filament are reunited at a distance of 2 to 3 cm.

No intermediate potentials are required. An X-ray method is used for the experimental investigation of its properties. The electron spot is a reduced image of the tip of the filament and has a diameter of about 40 μ. On the basis of this system, a fine focus X-ray tube is designed, with a peak specific target loading of about 11 kW/mm^2. Some performance data are given. A.

537.533.72 : 621.385.1.029.6

3567. Experimental verification of space charge and transit time reduction of noise in electron beams. C. C. CUTLER AND C. F. QUATE. *Phys. Rev.*, **80**, 875–8 (*Dec.* 1, 1950).

This paper describes a simple experiment which indicates some significant properties of the noise currents in a long electron stream, and verifies the applicability of the theory as worked out by Rack, Peterson and Pierce to the noise properties of klystrons and travelling-wave tubes. An appendix shows that the observations are reasonably consistent with the theory. A.

537.533.72 : 621.385.16.029.6

3568. Electron optical exploration of space charge in a cut-off magnetron. D. L. REVERDIN. *J. Appl. Phys.*, **22**, 257–62 (*March*, 1951).

The space charge distribution can be determined qualitatively from the measured electric field distribution. The first objective is the development of a convenient method for such a study. An elementary magnetron was investigated by sending an electron beam axially through the tube. The conclusions of the study are that the space charge distribution does not conform to Hull's classical theory (which predicts that the space charge density is approximately constant out to a well-defined radius and zero beyond this cloud radius). Three different space charge distributions have been observed. One distribution has a sharp maximum near the cloud radius. Another falls off gradually towards the cathode; a third is time-variant. The shape of the space charge distribution is closely related to the symmetry of the magnetron. A.

537.533.72 : 621.385.833

3569. The refractive index of electron optics and its connection with the Routhian function. W. GLASER. *Proc. Phys. Soc., Lond. B*, **64**, 114–18 (*Feb.*, 1951).

The derivation of the electron-optical refractive index from Hamilton's Principle is discussed. It is shown that the criticisms [Abstr. 1060 (1949)] of the author's method are invalid, whose derivation (1933) is correct. To prove that it is generally applicable, the isotropic refractive index of an axially symmetrical field is obtained. A.

537.533.74

3570. On the multiple scattering of fast electrons in aluminium. S. BRIMBERG. *Ark. Fys.*, **2**, *Paper* 44, 461–9 (1950) *In German.*

The multiple scattering of P^{32} β-rays by Al foils from 21 to 1 270 μ thick is investigated. In the range of thicknesses $x = 21$ to $x = 350\,\mu$ the average scattering angle is proportional to $x^{\frac{1}{2}}$, and has the maximum value $33{\cdot}2° \pm 0{\cdot}8°$. The mean energy obtained from the results by applying the Goudsmit–Saunderson formula agrees very well with the value obtained by Siegbahn [Abstr. 3195 (1946)]. This shows the validity of the formula for thin Al foils. J. HUGHES

537.533.74

3571. Geometrical method of calculating the back scattering of particles. L. VIGNERON. *C.R. Acad. Sci., Paris*, **232**, 226–8 (*Jan.* 15, 1951) *In French.*

Particles are produced inside a photographic emulsion. The ith track produced will be in an angle θ_i, vertex at the start of the track. If the mean angle for all the tracks observed is θ, then $\theta/2\pi$ is the probability that a particle emitted in a random direction, at the edge of the emulsion, will enter the emulsion and diffuse back out of it. S. MICHAELSON

537.533.74

3572. The application of variational methods to atomic scattering problems. I. The elastic scattering of electrons by hydrogen atoms. H. S. W. MASSEY AND B. L. MOISEIWITSCH. *Proc. Roy. Soc. A*, **205**, 483–96 (*March* 7, 1951).

The variational methods proposed by Hulthèn and by Kohn have been applied to the investigations of the elastic scattering of slow electrons by H atoms. Allowance has been made for both exchange and polarization effects in determining the zero-order phase shift. By comparison with results obtained by direct numerical integrations of the differential equations determining the scattering when the total wave function is assumed to have a separable form, it seems likely that both variational methods, which yield very nearly the same results, give satisfactory results except in certain sensitive cases, even when simple trial functions are employed. It is found that the inclusion of polarization (in the form of a non-separable wave function) is less important when exchange is included than when it is not. Reasons why this would be expected are given. Detailed results are obtained for electrons with energies up to 50 eV. A.

537.533.8

3573. Mechanism of the loss of energy by collisions in a material medium. I. M. SCHÖNBERG. *Nuovo Cim.*, **8**, 159–84 (*March*, 1951).

The theory of the loss of energy of a non-accelerated charged particle in a material medium is investigated, using classical electrodynamics. Special attention is given to the mechanism of the loss. The results of Fermi, Halpern and Hall, Wick and A. Bohr are generalized and further extended. The points of view of action at a distance (Bohr) and field theory (Fermi) are discussed and compared. The mechanism of the emission of Cerenkov radiation is examined and the relations with the emission of acceleration radiation analysed. A.

537.533.9 : 538.3 : 537.591

3574. Some consequences of radiation by very rapid particles in a magnetic field. B. KWAL. *J. Phys. Radium*, **11**, 685–90 (*Dec.*, 1950) *In French.*

The number of principal photons emitted in unit distance by a relativistic charged particle in a magnetic field is calculated on the theory of Arzimovich and Pomeranchuk [Abstr. 359 (1947)] and applied to the loss of energy of electrons in the betatron, and of

charged particles in the terrestrial and solar magnetic fields. A. O. STANESBY

537.534

3575. Design of acceleration chamber and dees for the 225 cm cyclotron at the Nobel Institute for Physics, Stockholm. H. ATTERLING. *Ark. Fys.*, **2**, *Paper* 50, 559–70 (1951).

537.534

3576. A 180° mass spectrometer for biochemical work. H. VON UBISCH. *Ark. Fys.*, **2**, *Paper* 46, 509–16 (1951).

Describes, with photographs and circuit diagrams, an instrument mainly intended for work with light elements. The 300 kg electromagnet has a gap of 4×8 cm cross-section, with a mean ion radius of 17·5 cm. There is provision for magnetic or electrostatic scanning. A filament-type ion source is used, with electronic regulation of the trap current. The pyrex analyser tubes are of elliptical cross-section, lined with gold-plated gauze for screening. A 3-stage air-cooled pump is used, with Octoil S and a dry-ice trap. Double or single collection may be used, with an electrometer valve and a feedback amplifier whose outputs may be compared in a potential divider. Mass spectra of CO_2 and SO_2 are given; reproducibility of abundance measurements is within 0·1–0·2%.

T. G. PICKAVANCE

537.534

3577. The exchange of charge between ions and atoms. J. B. HASTED. *Proc. Roy. Soc. A*, **205**, 421–38 (*Feb.* 22, 1951).

Charge-exchange cross-sections have been measured for ions of between 25 and 900 eV energy in collision with neutral atoms. The method involves collection and measurement of the charge-exchange ions when a beam is passed through gas. The cases A^+ in A, He^+ in He are in satisfactory agreement with the measurements of Rostagni, although showing no maxima at low energies. The cases O^+ in N_2, O^+ in A and N^+ in A show abnormally high values which are believed to be due to the presence of metastable ions, as well as contributions from the nitrogen rotational and vibrational energy. The cases H^+ in A, in Kr, in Xe and C^+ in Xe rise with an increasing energy, to a maximum when $a\Delta E/hv \simeq 1$, ΔE being the energy defect of the process, v the velocity of the incident ion and a a parameter of atomic dimensions $\sim$ (5 to 10) 10^{-8} cm. A.

537.534 : 621.384

3578. The acceleration of particles to high energies. *London, Institute of Physics* (1950) 58 *pp.*, 9 *plates.*

A symposium based on papers presented to an Institute of Physics Convention (1949). It is intended as an introduction to the basic principles and operation details for non-specialists. Sections: The cyclotron (J. Rotblat); Betatrons and synchrotrons (F. K. Goward); Electrostatic generators (E. S. Shire); Linear accelerators (E. S. Shire); Discussion on the papers.

537.534.72

3579. On the aberrations of ion lenses in ion sources. F. BERTEIN. *C.R. Acad. Sci., Paris*, **231**, 1448–9 (*Dec.* 18, 1950) *In French.*

Studies theoretically the aberrations introduced by the use of a focusing diaphragm, by considering it as a weak lens. J. THEWLIS

537.534.74 : 539.17 : 778.33

3580. Contribution to the methods of measurement of scattering in the photographic plate. R. L. SETTI. *Nuovo Cim.*, **8**, 96–107 (*Feb.*, 1951).

A comparison is made between the angular and the sagitta methods of measurement of scattering in the photographic plate. The analysis of the errors which may influence the computed energy of a particle makes it possible to define the limits of energy between which the two methods can give useful information and to determine the accuracy obtainable within these limits. Improvements are also described by which the elimination of systematic errors is made possible. A.

537.534.75 : 778.3

3581. A calculation, between 0·1 MeV and 8 MeV, of the range-energy relation for protons, as a function of the chemical composition of a photographic emulsion. A corresponding calculation for deuterons, tritons, and α-particles. A comparison with the experimental values in the case of the Ilford C_2 emulsion. M. BOGAARDT AND L. VIGNERON. *J. Phys. Radium*, **11**, 652–64 (*Dec.*, 1950) *In French.*

The energy loss for protons, as a function of energy, is taken, below 0·6 MeV, from recent measurements [Abstr. 2509 (1950)], and above this energy, calculated from Bethe's formula, using the ionization potentials experimentally determined by Mano. For the other particles the values are obtained relative to protons. For the Ilford C_2 emulsion, the calculated and experimentally determined range-energy curves agree, for protons in the range 0·1 to 5 MeV, and for α-particles in the range 2 to 13 MeV. Below 2 MeV, there is disagreement for α-particles, due both to experimental errors and deficiencies in the theory.

J. HUGHES

DISCHARGE TUBES . COUNTERS 537.54

537.542

3582. Photosensitive Geiger counters: their applications. C. E. MANDEVILLE AND M. V. SCHERB. *Nucleonics*, **7**, 34–8 (*Nov.*, 1950).

Geiger counters with ultraviolet-transmitting windows and photosensitive cathodes have been developed for the detection of light quanta in the region 2 000–3 000 Å. Great sensitivity is possible, since the counter requires only one electron to produce a discharge and quantum efficiencies as high as 10^{-2} to 10^{-1} have been reported. Applications of G.M. photon counters include their use in the detection of α-, β- and γ-radiations by the scintillation method. Among the phosphors which scintillate in the ultraviolet NaCl–Ag is mentioned. Efforts are being made to extend the sensitivity of the counters above 3 000 Å and α-particles on NaI–Tl (peak emission 4 100 Å) have been detected. L. R. SHEPHERD

537.542

3583. The efficiency of the Geiger–Müller counter for the high energy γ-rays. II. M. SONODA. *J. Phys. Soc. Japan*, **5**, 403–8 (*Nov.–Dec.*, 1950).

Continuation of Abstr. 7318 (1950). Calculates the efficiency of rectangular and cylindrical lead-wall

counters for different wall thicknesses (0·1–0·65 cm) for γ-ray energies of 6–17 MeV, taking into account the effect of multiple scattering and radiation losses of secondary electrons. A. O. STANESBY

537.542

3584. The efficiency of the Geiger–Müller counter for the high energy γ-rays. III. M. SONODA. *J. Phys. Soc. Japan*, **5**, 408–12 (*Nov.–Dec.*, 1950).

Continuation of preceding Abstr. Takes into account the effects of bremsstrahlung by a method similar to shower theory. A. O. STANESBY

537.542 : 539.166

Comparison of Geiger-counter and ion-chamber methods of measuring gamma radiation. *See Abstr.* 3751

537.542

3585. Proportional counters. II. S. A. KORFF. *Nucleonics*, **7**, 46–52 (*Nov.*, 1950).

See Abstr. 8061 (1950) for Part I. A brief outline of some of the important details in the design of proportional counters. The operation of neutron counters of the (n, α) and recoil type are described. Precautions in the construction of proportional counters and their filling are discussed.

L. R. SHEPHERD

537.542 : 621.218.572

3586. An alpha particle counter for students' experiments. R. L. WOOLLEY. *Electronic Engng*, **23**, 105–7 (*March*, 1951).

537.542 : 539.164

3587. Scintillation type alpha counter and its application in U and Th estimation of minerals. S. CHATTERJEE AND S. DHAR. *Indian J. Phys.*, **24**, 346–60 (*Aug.*, 1950).

Commercial 931 A photomultiplier tubes have been used, with a screen of Cossor oscillograph-type J as the phosphor. The luminescence spectrum of the phosphor and the microphotometer analysis are given. Application for U and Th estimation is described. The background counting rate of the system is 1·4 counts per hour due to radio-active contamination in the phosphor and highly ionizing cosmic radiations. Integral bias curves for Po and standard U source are given. Associated electronic circuits are discussed. The amplifier has an input time-constant of 5 μsec. The discriminator pulse-width is 100 μsec and can be decreased to 1 μsec for high rates of counting to which the apparatus is adaptable. The same arrangement can be used to detect U fission by neutrons. A.

537.542

3588. Statistical limitations on the resolving time of a scintillation counter. R. F. POST AND L. I. SCHIFF. Letter in *Phys. Rev.*, **80**, 1113 (*Dec.* 15, 1950).

An analysis is given of limitations on resolving time due to fluctuations in emission, transmission and collection of photons from scintillating crystals. Time spread of pulses in the photomultiplier is neglected. G. F. J. GARLICK

537.542

3589. Crystals for the scintillation Geiger counter. H. O. ALBRECHT AND C. E. MANDEVILLE. Letter in *Phys. Rev.*, **81**, 163 (*Jan.* 1, 1951).

See Abstr. 1128–9 (1951).

537.542

3590. A directional scintillation counter for clinical measurements. E. H. BELCHER AND H. D. EVANS. *J. Sci. Instrum.*, **28**, 71–5 (*March*, 1951).

A scintillation counter designed for clinical measurements is described. The instrument incorporates a liquid N-cooled photo-multiplier and a Tl-activated KI crystal separated from the photomultiplier by a Perspex light guide. Details are given of the absolute counting rates obtainable with 5 radioisotopes commonly used in clinical work and also of the directional properties of the instrument. The counting efficiency for the gamma radiation from I^{131}, expressed as counts/quantum incident on the crystal, is 31·6%. A.

537.542 : 537.531

3591. Detection of X-rays by means of NaI(Tl) scintillation counters. H. I. WEST, JR., W. E. MEYERHOF AND R. HOFSTADTER. Letter in *Phys. Rev.*, **81**, 141 (*Jan.* 1, 1951).

537.542

3592. Instrumentation and the atomic energy programmes. D. TAYLOR. *Trans Instrum. Meas. Conf., Stockholm* (1949) 291–6 (1950).

An account of instrument progress in the field. Instruments described include a quartz-fibre electrometer, with a discussion on methods of charging and practical constructional points. Its application to an ionization chamber is described and the design of a light-weight Geiger counter survey meter given. Circuit diagrams and illustrations are reproduced.

E. H. W. BANNER

537.542 : 533.5

3593. An automatic pressure stabilizing device for a diaphragm type Wilson cloud chamber. R. K. DAS. *Indian J. Phys.*, **24**, 466–8 (*Oct.*, 1950).

The development of this device has been necessary for the use of a specially designed metallic diaphragm of a shallow cloud chamber. A stabilization factor of $\pm$ 0·02% has been reached. A.

537.542

3594. Continuously sensitive diffusion cloud chamber. E. W. COWAN. *Rev. Sci. Instrum.*, **21**, 991–6 (*Dec.*, 1950).

The following types of continuously sensitive diffusion cloud chamber have been built and successfully operated: a chamber designed to be photographed through the top for use with a particle accelerator; a chamber designed to be photographed from the side for cosmic-ray studies; and a very simple chamber for demonstration purposes. The construction and best operating conditions are described. A.

537.542 : 621.389 : 621.387.4

3595. Progress in France in electronic instrumentation for nuclear physics. M. SURDIN. *Trans Instrum. Meas. Conf., Stockholm* (1949) 286–8 (1950).

A résumé of work on particle detectors of the Geiger type, with β-, γ-; end-window and ultraviolet photon counters; scintillation counters; ionization chambers; coincidence and linear amplifiers, amplitude discriminators and a time discriminator. Brief applications to radioactive survey equipment are made and a list of work in hand includes development on pile control, polarographs, accelerators and mass spectrographs. E. H. W. BANNER (R)

537.547 : 533.5 : 621.385

3596. The physical basis of the residual vacuum characteristic of a thermionic valve. G. H. METSON. *Brit. J. Appl. Phys.*, **2**, 46–8 (*Feb.*, 1951).

The physical basis of the form of the residual vacuum factor characteristic of a thermionic valve is investigated over the anode voltage range 50–250 V. The characteristic is found to be almost wholly due to soft X-ray radiation from the bombarded anode surface. The paper describes a method of separating X-ray photoelectric and ionic effects, and uses this separation to undertake low pressure measurements in the range 10^{-6}–10^{-9} mm of Hg. A.

IONIZATION . THERMIONICS 537.56/.58

537.561

3597. A study with a mass spectrometer of the decomposition of germanium hydride under the action of electronic bombardment. M. NÈVE DE MÉVERGNIES AND J. M. DELFOSSE. *Ann. Soc. Sci. Brux.*, **64**, *Ser.* 1, 188–95 (*Dec.* 13, 1950) *In French.*

The mass spectrometer is of the Dempster type, and the magnetic field is furnished by a permanent magnet of Alnico. The ion current is measured by an FP54 electrometer. The resolving power is about 180. The probability of formation and the appearance potentials of the various free radicals, formed by the dissociation of the GeH_4 under electron bombardment, were measured. The results enabled an estimate to be made for the average binding energy of the bond Ge–H. J. HUGHES

537.583

3598. Some remarks on the equation of thermionic emission. Y. WATANABE. *Techn. Rep. Tohoku Univ.*, **14** (*No.* 1) 1–9 (1949).

The equation of thermionic emission of a pure metal surface is expressed in two forms: viz. Richardson's and Dushman and Nordheim's equations. These equations have been usually regarded as independent of each other. The author purposes to show that the two equations indicate the same content, should an apparent electron density for the Richardson's equation be taken as $n^* = 2(2\pi mkT)^{3/2}/h^3$. A.

537.583

3599. The use of radioactive elements for the study of oxide cathodes. J. DEBIESSE, J. CHALLANSONNET AND G. NEYRET. *C.R. Acad. Sci., Paris*, **232**, 602–4 (*Feb.* 12, 1951) *In French.*

Cathode sleeves were subjected to neutron bombardment. Most cathodes showed little activity 10 days after the irradiation, but one alloy showed considerable activity even after 180 days. The effect is due to Co. Standard alloys of Ni and Co were prepared and tested after 7 days of bombardment in the Chatillon pile. The activities were directly proportional to the Co content, and the method is extremely sensitive as a means of detecting Co in Ni. The radiation consists of γ-rays of energies 1·1–1·4 MeV and β-rays of energies 130–700 MeV. A. H. W. BECK

537.583 : 621.385.032.216

3600. Oxide cathode base metal studies. R. FORMAN AND G. F. ROUSE. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 30–7 (*Jan.*, 1951).

A method for comparing the properties of two oxide cathodes, one with a high-purity Ni base and the other with a Ni base containing a small percentage of Mg, is discussed. Data are presented showing the effect of Mg on the rate of electrolytic activation and life of an oxide cathode. The influence of the cathode and anode on pulsed current decay at high current densities is also discussed. A.

537.585 : 621.385.032.2

3601. A positive emission from heated cathodes. K. H. STEIGERWALD. *Z. angew Phys.*, **2** (*No.* 12) 491–3 (1950) *In German.*

Electron guns for electron microscopy in which a tungsten hairpin is used as emitter show a positive emission of 10^{-9}–10^{-8} A during the first hour of operation between 1 300–1 800°K. The decay is more rapid the higher the temperature. The emission is due to an evaporation phenomenon, the evaporated substance being ionized only in the stated temperature range. A. H. W. BECK (R)

537.583 : 621.385.032.21

3602. Boride cathodes. J. M. LAFFERTY. *J. Appl. Phys.*, **22**, 299–309 (*March*, 1951).

The thermionic emission properties of the borides of the alkaline-earth and rare-earth metals and Th have been investigated. These compounds all have the same formula MB_6 and the same crystal structure consisting of a 3-dimensional B framework in whose interlattice spaces the metal atoms are embedded. When this structure is heated to a sufficiently high temperature, the metal atoms at the surface evaporate away but are immediately replaced by diffusion of metal atoms from the underlying cells. The B framework does not evaporate but remains intact. This process constantly maintains an active cathode surface. The rare-earth metal borides are superior to the others, the highest emission being obtained from LaB_6. Its emission constants for the Dushman equation were $\phi = 2{\cdot}66$ V and $A = 29$ A/cm²/deg K². LaB_6 has a relatively low evaporation rate corresponding to a latent heat of evaporation of 169 kilocal per mole. If the hexaborides are operated at high temperature in contact with the refractory metals, B diffuses into their metal lattices forming interstitial B alloys with them and the B framework collapses, permitting evaporation. However, the hexaboride cathodes may be operated at high temperatures in contact with Ta carbide or graphite. LaB_6 cathodes are useful where high current densities are required; also for high voltage applications because they stand up well under positive ion bombardment. A.

COSMIC RAYS 537.591

537.591 : 778.3

Cosmic-ray investigations with special photographic emulsions. *See Abstr.* 4023

537.591.1

3603. Mass measurements on cosmic-ray particles. C. Peyrou and A. Lagarrigue. *J. Phys. Radium*, **11**, 666–72 (*Dec.*, 1950) *In French.*

Experiments at 1 000 m altitude are reviewed in which the momentum of single cosmic-ray particles is measured in a cloud chamber 70 cm deep in magnetic fields up to 1 750 gauss, and the residual range is determined to within 16·5 g.cm^2 in a succession of Pb plates separating counter trays. The errors to which the method is subject are critically examined. Results: the μ-meson mass is measured to be $(212 \pm 5)m_0$, and the relative number of protons to mesons of similar range is determined, and is shown to decrease strongly with increasing thickness of Pb placed above the whole apparatus. There is no positive evidence of the existence of particles of abnormal mass. J. G. WILSON

537.591.1

3604. The ratio of electrons to mesons 1 100 feet underground. C. A. Randall and W. E. Hazen. Letter in *Phys. Rev.*, **81**, 144–5 (*Jan.* 1, 1951).

The ratio was determined as a function of electron energy from 3 MeV to 100 MeV, from the absorption in C of the soft component. The results are close to the values expected assuming the electrons are produced by extra-nuclear electromagnetic processes of μ-mesons. E. P. GEORGE

537.591.1

3605. Distribution of slow neutrons in free atmosphere up to 100 000 feet. L. C. L. Yuan. *Phys. Rev.*, **81**, 175–84 (*Jan.* 15, 1951).

For preliminary reports see Abstr. 5105 (1950). Two identical proportional counters filled with BF_3 of 96% B^{10} have been sent aloft up to an altitude of 102 000 ft at a geomagnetic latitude of 51° 46′ N by means of free balloons. One counter was shielded with 0·030 in of Cd, and the other enclosed in Sn of the same thickness for the compensation of possible effects caused by "stars" produced in the Cd shield. The difference in the counts of the two counters is due only to slow neutrons ($E \leqslant 0{\cdot}4$ eV). The counts and the pressure and temperature were radioed down by an FM telemetering system. Up to about 20 cm of Hg the counts increase exponentially with altitude according to an absorption depth $\lambda = 156$ g/cm^2, in agreement with previous measurements, and roughly with the increase of "stars" in the atmosphere. The counts of both counters as well as their difference show a maximum at high altitude, as expected theoretically. The maximum for the Cd difference counts appears at about 8·5 cm Hg pressure and drops down sharply to about one-fourth of its maximum value at 1 cm Hg. The counter sensitivity was calibrated against a standard neutron source and the absolute number of slow neutrons absorbed per gram and second in the atmosphere is computed and compared with the number of protons produced at the same altitudes. A.

537.591.1

3606. Composition of the hard component of cosmic radiation in the stratosphere. N. L. Grigorov. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 3) 381–4 (1951) *In Russian.*

Theoretical. A method is given for separating the hard component into μ-mesons, and stable particles (assumed nucleons) at all heights in the atmosphere. The calculated results appear consistent with direct observations of the nucleon component. E. P. GEORGE

537.591.15

3607. On penetrating showers generated in lead and carbon. L. Mezzetti and R. Querzoli. *R.C. Ist. Super. Sanità*, **13** (*No.* 6–8) 489–502 (1950) *In Italian.*

The dependence of the generation cross-section of penetrating showers produced by ionizing agents upon the atomic number of the material crossed by the primaries has been studied by an arrangement of G.M. counters which was sensitive to showers of comparatively low penetrating power. The frequencies of penetrating showers generated in relatively small thicknesses of Pb and C have been compared and a value $\lambda_{Pb}/\lambda_C = 4{\cdot}4 \pm 1{\cdot}0$ for the ratio of the collision mean free paths has been deduced. The dependence of the observed production rate upon the total number of ionizing particles in the shower has been also investigated, and the results have been compared with theoretical distributions as given by plural-production and multiple-production theories; but the results obtained do not allow of a choice between the theories. A.

537.591.15

3608. A study of the density spectrum of atmospheric showers of cosmic particles. L. Kh. Eĭdus, M. M. Alymova and V. G. Videnskiĭ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 669–72 (1950) *In Russian.*

The exponent γ of the density spectrum was determined by the 2 standard methods for counter separations, D, up to 400 m. For D 112 and 400 m, γ was found to jump from the value $\sim 1{\cdot}5$ found for smaller D, to the value $\sim 2{\cdot}0$. The showers are pictured as containing a central region ($D < 70$ m at s.l.) where electron-photon cascades predominate, surrounded by a region extending up to ~ 1 km where nucleon cascades predominate. E. P. GEORGE

537.591.15

3609. Penetrating showers from lithium. W. B. Fretter. Letter in *Phys. Rev.*, **80**, 921–2 (*Dec.* 1, 1950).

These were studied in order to throw light on the question of plural or multiple production. A Li block was placed over a cloud chamber containing Pb plates. 14 penetrating showers originated in the Li block (a rate of 3 per month) and several of these had multiplicities of charged particles too large to be explained on the plural theory. The largest event contained 10 penetrating plus 3 other charged particles. E. P. GEORGE

537.591.15

3610. Study of showers in sensitive emulsions. F. Bousser, M. Della Corte, and L. Jauneau. *Ric. Sci.*, **21**, 43–7 (*Jan.*, 1951) *In Italian.*

Ilford G.5 nuclear plates have been exposed at 28 000 m altitude. By plotting the ratio of number of stars with more than 8 prongs to number of stars with $n \leqslant 8$ against the number of relativistic tracks in the star is shown that the number of soft particles is not a sufficient criterion to ascribe the star to a

heavy or light nucleus. The frequency of stars was also plotted against the number of relativistic particles; the resulting distribution curve shows that the energy spectrum of those star-generating particles which are themselves disintegration products is falling with energy more rapidly than does the corresponding spectrum of primary particles. Finally the angular distribution of relativistic particles does not appear to agree with a scheme based on multiple production alone. A.

537.591.15

3611. High energy cosmic-ray showers in nuclear emulsions. L. S. Osborne. *Phys. Rev.*, **81**, 239–44 (*Jan.* 15, 1951).

A detailed and statistical study of high-energy events in nuclear emulsions exposed at high altitudes has given some information on a model to describe the showers found in cosmic rays. There is evidence shown that shower multiplicity increases with primary energy. Differences in the behaviour of events from heavy and light nucleus collisions are described. From multiplicity and angular spread of the tracks in individual events, arguments are presented to support a pluromultiple model for meson production in high-energy collisions with a nucleus. A.

537.591.15

3612. Possible existence of primary cosmic ray showers. A. Rogozinski. *C.R. Acad. Sci., Paris*, **232**, 328–30 (*Jan.* 22, 1951) *In French.*

The conditions under which particles of common parentage can reach the earth simultaneously to within the resolving power of detecting equipment are examined. All processes depending on the collisions of primary nucleons in interstellar matter are shown to be ineffective, and possible sources of such primary showers must accordingly be near (e.g. sun). Experimental methods of searching for primary showers are indicated. J. G. WILSON

537.591.3

3613. Anomalies in the absorption curve of cosmic rays in lead. E. M. de Mathov. Letter in *Nature, Lond.*, **167**, 192–3 (*Feb.* 3, 1951).

The absorption of near-vertical cosmic-ray particles measured with a threefold counter telescope below Pb absorber at sea level (Buenos Aires) shows an anomalous maximum of intensity under 13 cm Pb + 30 cm concrete roof. J. G. WILSON

537.591.3

3614. Absorption of penetrating shower secondaries. D. M. Ritson. *Phil. Mag.*, **42**, 250–4 (*March*, 1951).

Measurements with a penetrating shower set at sea level showed an apparent mean free path for absorption of the secondaries of penetrating showers of 405 ± 30 g/cm² for Pb and 350 ± 40 g/cm² for Fe. A.

537.591.5

3615. A search for cosmic-ray diurnal effects at balloon altitudes. T. A. Bergstralh and C. A. Schroeder. *Phys. Rev.*, **81**, 244–7 (*Jan.* 15, 1951).

In two balloon flights in Minnesota a search was made for diurnal effects in the cosmic radiation at altitudes above 50 000 ft. Measurements were made simultaneously of the total ionizing radiation, γ-radiation in the energy range of approximately 0·75 to 5 MeV, and fast neutrons. The ionizing radiation and γ-radiation component was measured by means of a central horizontal counter tube surrounded by a closely packed ring of horizontal counters. Coincidences between the central counter and the outer ring determined the ionizing radiation, while anticoincidences gave the intensity of the γ-radiation. The neutron flux was measured by two BF_3 counters, one filled with enriched BF_3, mounted side by side in a vertical paraffin cylinder of 8 in dia. surrounded by Cd. One flight was launched at 12.30 a.m. LCT and remained aloft until 8.30 a.m. The other flight was launched at 6.00 p.m. and landed at 10.00 p.m. No diurnal effects were observed. The statistical accuracy of this measurement is of the order of 1% for the total ionizing radiation, 3% for the γ-radiation, and 2% for the neutron measurement. A.

537.591.5 : 551.594.6

3616. The cosmic ray intensity and radio fade-outs. D. W. N. Dolbear, H. Elliot and D. I. Dawton. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 187–8 (1951).

The behaviour of the cosmic-ray intensity during radio fade-outs has been investigated by superimposing the data for 35 fade-outs occurring between 0900 and 1600 hrs G.M.T. It is found that there is, on the average, an increase of $\sim 0{\cdot}3\%$ in the intensity at the time of such a fade-out. The effect appears to depend on local time since fade-outs are not accompanied by any corresponding increase in cosmic-ray intensity on the dark side of the earth. A.

537.591.8

3617. The angular distribution of the secondary electrons of the hard component of cosmic rays. O. Madelung. *Naturwissenschaften*, **37** (*No.* 23) 538–9 (1950) *In German.*

Theoretical. Expressions are given based on the angle of emission of the initially produced electron or γ-ray, and the scattering of the subsidiary cascade particles. E. P. GEORGE

537.591.8

3618. An unusual nuclear event. P. R. Barker. Letter in *Phys. Rev.*, **81**, 291 (*Jan.* 15, 1951).

A cloud-chamber picture shows a star produced by a charged particle in the 3rd plate of a multiplate chamber. Starting in lower plates are 2 separate cascade showers. No charged penetrating particles are observed. The quantitative data are discussed in terms of π° meson emission. E. P. GEORGE

537.591.8

3619. On the angular distribution of the prongs of stars produced by cosmic rays in photographic emulsions. A. Manfredini. *Nuovo Cim.*, **8**, 195–205 (*March*, 1951) *In Italian.*

This has been measured, with particular reference to the stars with 3, 4 and 5 prongs. Using the angular distribution of the recoil nuclei studied by Harding, an upper limit for the contribution to the observed stars due to heavy atoms in the emulsion can be determined. This limit is less than 50% in contradiction with the hypothesis that the cross-section for the generation of the stars is proportional to the geometrical cross-section of the nucleus. A.

537.591.8 : 539.165

3620. Radioactive nuclei emitted in cosmic-ray stars. E. PICKUP AND L. VOYVODIC. Letter in *Phys. Rev.*, **80**, 1100–1 (*Dec.* 15, 1950).

Evidence of β-decay of emitted fragments and of residual nuclei of stars formed in G5 emulsion at 85 000′ is presented. β-active fragments are about as frequent as Li^8 nuclei and give rise to relatively energetic decay electrons: the β-particles from residual nuclei are generally of lower energy.

J. G. WILSON

537.591.8 : 539.172

3621. Nuclear disintegrations at high altitude. M. M. ADDARIO AND S. TAMBURINO. *Nuovo Cim.*, **8**, 82–95 (*Feb.*, 1951) *In Italian.*

Stars produced by cosmic radiation on Ilford C_2 plates at 29 000 m above sea level have been studied. It is inferred that the radiation producing them is largely composed of primary nucleons. The number of α-particles emitted by stars was plotted *v.* kinetic energy, and the ratio of α-particles to all particles emitted was calculated. The conclusion is reached that the distribution of particles emitted in a nuclear evaporation depends neither on the excitation energy or the energy of the star-producing radiation. An anomalous distribution of stars was observed in the plates, which seems to be independent of altitude. A.

MAGNETISM 538

538.114

3622. A note on the classical spin-wave theory of Heller and Kramers. M. J. KLEIN AND R. S. SMITH. Letter in *Phys. Rev.*, **80**, 1111 (*Dec.* 15, 1950).

For a linear chain of atoms with nearest neighbour spin-spin couplings, the zero-point energy found by Heller and Kramers [*Proc. K. Akad. Amsterdam*, **37**, 378–85 (1934)], who develop an approx. classical theory and then quantize, is shown to be absent when the quantal Hamiltonian of Holstein and Primakoff [Abstr. 288 (1941)] is approximated in corresponding conditions. The physical interpretation of this discrepancy is discussed.

R. H. DALITZ

538.12

3623. Determination of optimum parameters of magnetic systems with permanent magnets. A. YA. SOCHNEV. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 1) 65–8 (1951) *In Russian.*

Gives a general method of the analysis of magnetic systems with permanent magnets, by means of which it is possible to determine the optimum values of all parameters of magnetic systems for a minimum magnet weight and a maximum field intensity in the working space. F. LACHMAN

538.214

3624. Periodic field-dependence at the magnetic susceptibilities of metals at low temperatures. B. I. VERKIN, B. G. LAZAREV AND N. S. RUDENKO. Letter in *J. Exp. Theor. Phys., USSR*, **20**, 93–4 (*Jan.*, 1950) *In Russian.*

[This abstract supplements Abstr. 486 (1951)]. The de Haas–van Alphen effect has been found in Be, Mg, In and Cd. For Be the period of oscillation is 1 000 G at 12 000 G, and the effect is observable at 20°K. For Mg the period is 280 G at 14 000 G and the effect is marked at 4·2°K and below. For In and Cd the periods are only of order 40 G at 14 000 G and the effect becomes marked only below 2°K. [See also Dingle and Shoenberg, Abstr. 1176 (1951)]. D. SHOENBERG

538.214

3625. Periodic relation between the magnetic permeability and the field at low temperatures. YU. B. RUMER. Letter in *J. Exp. Theor. Phys., USSR*, **20**, 573 (*June*, 1950) *In Russian.*

[This abstract supplements Abstr. 487 (1951)]. The well-known fact that at sufficiently low fields the period of oscillation of the de Haas–van Alphen effect varies approximately as the square of the field is pointed out, both on the basis of theory and on the basis of the experiments of Verkin, Lazarev and Rudenko (see previous abstract). [See also Shoenberg, Abstr. 1830 (1939), 1071 (1950)].

D. SHOENBERG

538.22

3626. Magnetic properties of magnetite containing substituted Al^{3+} ions, in relation to its structure. C. GUILLAUD AND A. MICHEL. Letter in *J. Phys. Radium*, **12**, 65 (*Jan.*, 1951) *In French.*

The saturation moment was found to decrease linearly with x, the concentration of Al^{3+} ions, extrapolating to 1 μ_B (*cf.* 4 μ_B for Fe_2O_3) for $x = 1$. This result is discussed on the basis of Néel's considerations. E. P. WOHLFARTH

538.221

3627. Investigation of the magnetic resources of alloys of manganese with nickel and cobalt. F. GALPERIN. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 4) 515–18 (1950) *In Russian.*

Calculations and experiments are described which are held to prove that Mn contributes to its alloys with Ni and Co an almost uniform atomic magnetic moment, due to the fact that both Ni and Co have very similar types of crystalline structure. Consequently, it is contended that the second component of the alloy has an atomic magnetic moment actually dependent on the structural type of the solvent, here assumed to be Mn. The argument is illustrated by graphs showing the curves of dependence of atomic magnetic moment of (*a*) Ni alloys and (*b*) Co alloys on concentration of Mn presented in accordance with the data obtained from the calculations and experiments described. Results are also given in tabular form. J. CLEUGH

538.221 : 537.311.33

3628. Microwave resonance absorption of $NiOFe_2O_3$. T. OKAMURA, Y. TORIZUKA AND Y. KOJIMA. Letter in *Phys. Rev.*, **80**, 910–11 (*Dec.* 1, 1950).

Ferromagnetic resonance absorption in the semiconductor $NiOFe_2O_3$ at 4 051 and 9 317 Mc/s lead to g values of 2·05 and 2·26 respectively, consistent results being obtained with spheres and disks.

D. H. WHIFFEN

538.221 : 537.312.5

3629. Superficial photoelectric effect in ferromagnetics. S. V. Vonsovskiĭ and A. V. Sokolov. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 197–200 (1951) *In Russian.*

An attempt to give a theoretical explanation of the results of Cardwell's research [Abstr. 7112 (1949)] relating to the anomalous photoelectric-current/temperature relationship and the increase of work function with temperature found in ferromagnetic Ni. Using Vonsovskiĭ's model of mutual interaction between external *s*-electrons and internal *d*-electrons, a conclusion is reached that the photoelectric current in ferromagnetics should depend upon the magnitude of their spontaneous magnetization. F. LACHMAN

538.221 : 539.154.3

3630. Investigation of the magnetic properties of ordered alloys. F. Galperin. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 647–50 (1950) *In Russian.*

Measurements were made on 5 ferromagnetic ordered alloys: Ni_3Mn, Ni_3Fe, FeCo, MnBi and CrTe. Phase changes during the formation of these compounds were followed by measuring the susceptibility. Observed values of the atomic magnetic moments in the ordered and disordered states are compared with values calculated from the author's formula [Abstr. 6022 (1950)] and satisfactory agreement is obtained. A. L. MACKAY

538.221 : 539.374

3631. The effects of plastic deformation on magnetic properties of polycrystalline metals. U. M. Martius. *Canad. J. Phys.*, **29**, 21–31 (*Jan.*, 1951).

One of the most important factors determining the size and arrangement of ferromagnetic domains in a single crystal is the tendency to close the magnetic flux throughout the specimen by a suitable arrangement of these domains. The size of the crystal defines the limits within which the flux can be closed. In a polycrystalline metal, a "crystal" is defined as a region of one crystallographic orientation separated by crystal boundaries from neighbouring regions of different orientation. The corresponding unit, as far as ferromagnetic properties are concerned, will be a *closed flux shell* which may contain many domains but is always a region of closed magnetic flux. Neighbouring regions, having different crystallographic orientation, will each also consist of a closed magnetic flux shell. Crystal boundaries are regarded as lattice discontinuities which separate regions of different orientation and at the same time separate different closed flux shells. The consequences of this model and experimental evidence supporting it are discussed. An explanation of the effect of plastic deformation on magnetic properties is suggested by considering the changes in the size of the closed flux shell which will occur during plastic deformation. A.

538.221 : 621.318.042.15

3632. Frequency variation of magnetic after-effect in powder cores. R. Feldtkeller and H. Hettich. *Z. angew. Phys.*, **2** (*No.* 12) 494–9 (1950) *In German.*

When losses in powder cores are divided into hysteresis, eddy-current and after-effect (a.e.) components, it has been so far assumed that Jordan-a.e. can be represented by a frequency-independent coefficient. Investigations by Schulze on the Richter-a.e. which occurs in transformer laminations having space-centred crystals and is strongly temperature-dependent, show that it varies markedly with frequency. It is shown here that Jordan-a.e., which is found in space-centred as well as in face-centred crystals, is not completely independent of frequency. It is shown how the losses can now be divided. In this analysis the variation of inductance with frequency must be taken into account. Experimental results are presented. S. C. DUNN (R)

538.222

3633. Nuclear spin relaxation times in single crystals of LiF. R. V. Pound. Letter in *Phys. Rev.*, **81**, 156 (*Jan.* 1, 1951).

538.222

3634. Spin-spin interaction within paramagnetic salts. M. H. L. Pryce. Letter in *Phys. Rev.*, **80**, 1107–8 (*Dec.* 15, 1950).

The magnetic spin-spin interaction of the Fe transition group metal ions is expressed theoretically in terms of $\boldsymbol{L}$, $\boldsymbol{S}$ and the electronic wave functions and its influence on paramagnetic resonance absorption is discussed. D. H. WHIFFEN

538.222

3635. Kramer's theorem and nuclear effects in paramagnetic absorption. C. Kikuchi. Letter in *Phys. Rev.*, **81**, 155–6 (*Jan.* 1, 1951).

It is shown that a relation between the h.f.s. component separation and the angle between the crystal axis and the magnetic field, similar to that first derived by Pryce for the Co-ion [Abstr. 6332 (1949)], may be deduced by general quantum mechanical methods. L. PINCHERLE

538.222

3636. A simplified apparatus for the study of paramagnetic nuclear absorption. R. Gabillard. *C.R. Acad. Sci., Paris*, **232**, 324–6 (*Jan.* 22, 1951) *In French.*

538.222

3637. Magnetic susceptibility and anisotropy of mica. J. T. Kendall and D. Yeo. *Proc. Phys. Soc., Lond. B*, **64**, 135–42 (*Feb.*, 1951).

The magnetic susceptibility and anisotropy of natural muscovite and synthetic fluorphlogopite have been measured. These minerals contain small quantities of Fe which cause paramagnetic and ferromagnetic effects. To a fair approximation the mean susceptibility is found to vary linearly with the total Fe content, and the paramagnetic anisotropy to be proportional to the ferrous Fe content. At low field strengths ferromagnetic impurities (probably submicroscopic inclusions of magnetite) cause anomalous results. It is shown that such inclusions are present in all the micas examined, and account for the apparent paramagnetism of synthetic mica. The inclusions are probably orientated with their magnetic axes in a preferred direction relative to the crystallographic axes of the mica. A.

538.222

3638. The paramagnetic resonance spectra of two salts of manganese. B. Bleaney and D. J. E. Ingram. *Proc. Roy. Soc. A*, **205**, 336–56 (*Feb.* 22, 1951).

The magnetic resonance spectra of Mn fluosilicate.

and Mn ammonium sulphate have been analysed using centimetre wavelengths. It is shown that the splitting of the ^6S state is due mainly to the non-cubic symmetry of the crystalline field; the effect of the cubic field, hitherto assumed to be dominant, appears only as a small correction. The spectra show that the splitting is consistent with a mechanism suggested by Abragam and Pryce, where it is attributed to magnetic interaction between the 5 electrons constituting the ^6S state. An extensive hyperfine structure is resolved, and the nuclear spin ($\frac{5}{2}$) of ^{55}Mn is confirmed. The spectroscopic splitting factor, g, is $2{\cdot}000 \pm 0{\cdot}001$, very close to the free-spin value. The energy levels in zero magnetic field are evaluated for Mn ammonium sulphate. A.

538.222 : 538.69

3639. Paramagnetic resonance and the effect of resonance on the magnetic birefringence of radio waves. A. Kastler. *C.R. Acad. Sci., Paris*, **231**, 1462–4 (*Dec.* 18, 1950) *In French.*

For radio waves parallel and perpendicular to a magnetic field a magnetic rotatory polarization and a magnetic birefringence are observed respectively. These are analogous to the Zeeman optical effect. W. R. ANGUS

538.222 : 539.152.2

3640. On the nuclear magnetic resonance in an antiferromagnetic crystal. N. Bloembergen and N. J. Poulis. *Physica*, **16**, 915–19 (*Dec.*, 1950).

The observation of the nuclear magnetic resonance in antiferromagnetic crystals should give information about the spin alignment in these crystals. An attempt to observe the F^{19} resonance in a single crystal of MnF_2 yielded a negative result. The absence of the nuclear resonance is attributed to a very short nuclear relaxation time ($< 10^{-6}$ sec). A.

538.224 : 539.132

3641. The diamagnetic anisotropy of large aromatic systems. I–II. R. McWeeny. *Proc. Phys. Soc., Lond. A*, **64**, 261–75 (*March*, 1951).

I. A short discussion is given of the magnetic properties of large aromatic hydrocarbons and of the applicability of various wave-mechanical methods of calculating the diamagnetic susceptibility. The ultimate particles of most cokes and carbon blacks are not sufficiently large to be regarded as crystalline and must be treated as large molecules: calculations on certain simple types of molecule are to be carried out with a view to elucidating the effect of particle size and shape on the magnetic properties of such carbons. For systems of these dimensions the molecular orbital method should be valid and, in fact, appears to constitute the only feasible approach to the problem. II. The method of molecular orbitals is applied in a discussion of the diamagnetic anisotropy of the *p*-polyphenyls, which may be regarded as the simplest type of aromatic chain molecule. An almost perfectly linear relationship is predicted between diamagnetic anisotropy and chain length: in this case the molecular orbital method should be valid for chains of up to at least 2 000 rings. The results are discussed and the desirability of further accurate experimental work on these molecules is pointed out: this would make possible a stringent test of the whole theory. A.

538.24

3642. The phenomenon of counter inversion in ferromagnetics. L. V. Kirenskiĭ and V. F. Ivlev. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 3) 389–91 (1951) *In Russian.*

A sample of well-annealed Ni was subjected to a magnetic cycle in which the rate of change of the magnetic field stress could be changed from 0·001 to 1 oersteds/sec. An apparatus was used whereby separate Barkhausen impulses could be registered on a telegraphic tape, simultaneously with the recording on photographic paper of the induction current caused by the sudden changes in the intensity of magnetization in the sample, for smooth and very slow increases in the tension of the magnetic field. In addition to the Barkhausen impulses corresponding to the sudden increase in the intensity of magnetization for a smoothly increasing field, there were also observed reverse impulses corresponding to decreases in the magnetization vector with growth of the field. This phenomenon is called *counter inversion*. The number of these counter inversions is considerable and amounts to $\sim 35\%$ of the number of Barkhausen impulses. The phenomenon was observed both on the original curve and on the hysteresis loop curve. W. HUGHES

538.245

3643. Some rules for magnetic viscosity. R. V. Telesnin. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 659–60 (1950) *In Russian.*

The author claims to have established (1937–48) the proportionality of the magnitude of magnetic viscosity to the magnitude of the differential receptivity $\chi d = \mathrm{d}J/\mathrm{d}H$. The theory proposed by P. Street and J. C. Wolley [Abstr. 384 (1950)] does not include the author's proportionality between the time of relaxation and χd. He shows how it may be allowed for, with the result that (rule I) relaxation time is found to be directly $\propto$ differential receptivity and inversely $\propto$ absolute temperature. It is argued accordingly that (rule II) viscosity does not depend on the magnitude of change within the field ΔH (unless the latter is very small) but merely on the final condition of the ferromagnetic substance. J. CLEUGH

538.245

3644. Dependence of magnetic viscosity on temperature. R. V. Telesnin and E. F. Kuritsyna. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 6) 797–8 (1950) *In Russian.*

Describes the application of rule I in the preceding Abstr. to a particular substance (Ni from 86° to 615°K, i.e. practically to Curie point). Diagrams show: (i) curves of relaxation time and of differential receptivity in dependence on absolute temperature; (ii) curves of magnetization, hysteresis and the curves of (i) at different temperatures; (iii) the values of the coefficient A at different temperatures, dependent on the field. The A values are found to be practically constant and thus the validity of rule I in practice is demonstrated. J. CLEUGH

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

3645. On the calculation of the field produced by a helicoidal circuit. E. ROUBINE. *C.R. Acad. Sci., Paris*, **232**, 221–2 (*Jan.* 15, 1951) *In French.*

A monochromatic wave propagates inside the helix. Expressions are given for the field components at any point on the axis. L. PINCHERLE

538.3 : 530.145

3646. On the e.m. field "orthogonal" in space-time. I. A. M. PRATELLI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **9**, 251–6 (*Nov.*, 1950) *In Italian.*

For fields with the property $E \cdot H = 0$ theorems are established representing the extension to four dimensions of some of the laws of electromagnetism. L. PINCHERLE

538.3 : 532.5

3647. Dynamics and electromagnetism. V. BJERKNES. *Avh. Norske Vidensk. Akad., Oslo, I. Mat.-Nat.Kl., No.* 1, 12 *pp.* (1949).

A modification of the electromagnetic equations is proposed, in accordance with a hydrodynamical analogy. The proposed equations predict that a static electric field would be altered by adding a static magnetic field, but experiments have not yet detected any such effect. P. M. DAVIDSON

538.521

3648. Electromagnetic induction in a semi-infinite conductor with a plane boundary. A. T. PRICE. *Quart. J. Mech. Appl. Math.*, **3**, 385–410 (*Dec.*, 1950).

The general theory of the induction and free decay of currents is considered. The solutions of the fundamental equations are of 2 types, which correspond to 2 distinct modes of decay of currents in the conductor. The properties of these modes are investigated. Detailed calculations are made of the induced field and currents produced by a periodic or aperiodic line current parallel to the face of the conductor, and the method of calculation for any other inducing fields is indicated. An explanation is given of the indeterminate character of certain problems. A.

538.54

3649. Heating of a hollow metal sphere by induction. A. COLOMBANI. *J. Phys. Radium*, **12**, 26–30 (*Jan.*, 1951) *In French.*

Theoretical. The power dissipated by eddy currents reaches a maximum when the thickness equals $3/4\pi\omega\sigma a$, where a is the external radius of the sphere. L. PINCHERLE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.563 : 535.568.1 : 621.317.3.029.6

3650. Hertzian polarimetry of helical rotators. R. SERVANT AND P. LOUDETTE. *C.R. Acad. Sci., Paris*, **231**, 1465–6 (*Dec.* 18, 1950) *In French.*

With the apparatus described earlier [Abstr. 1946 (1951)] curves of rotatory dispersion of polarized electromagnetic waves are determined for wire helices wound on cylindrical bakelite or cardboard formers. Anomalous dispersion and circular dichroism are observed near regions of absorption. C. B. ALLSOPP

538.563 : 535.568.1 : 621.396.11

3651. Macroscopic realization of a "Cotton effect" with radio-waves. R. SERVANT AND P. LOUDETTE. *C.R. Acad. Sci., Paris*, **232**, 46–8 (*Jan.* 3, 1951) *In French.*

It was shown previously (see preceding Abstr.) that a helicoidal resonator rotates the plane of polarization of an e.m. wave. It has now been proved that, if the wavelength is near the absorption region of the resonator, the emerging wave is elliptically polarized, showing complete analogy with the Cotton effect. The order of magnitude of the effect is considerable, and probably circular vibrations may be obtained by this method. L. PINCHERLE

538.563 : 621.317.34

3652. Sensitivity of a radiometer. V. I. BUNIMOVICH. *J. Tech. Phys., USSR*, **20**, 944–53 (*Aug.*, 1950) *In Russian.*

Expressions were derived for signal and noise intensity and hence of sensitivity, at the output side of a radiometer with quadratic and linear detectors. The instrument was designed for detection and measurement of radiations of a fluctuating nature in the r.f. range, on the principle of a modulation of the noise received, i.e. the periodic superposition of the investigated radiation on the oscillations of a local standard oscillator. It is possible to compare the investigated radiation with the standard oscillation during a period of the order of the modulation period. The noises received have an additional modulation of a fluctuating character. This "fluctuation modulation" may be regarded partially as fluctuation of the amplification factor of the i.f. amplifier. Systematic modulation by a special modulator eliminates the bad influence of fluctuation modulation. The modulator consists of a rotating, partially conducting disk set into a slot of a rectangular waveguide, so that modulation of noise has square form (modulation frequency 30 c/s). Sensitivity is calculated first only for local modulation frequency which is sufficiently high for fluctuation frequency to be neglected. B. F. KRAUS

538.565 : 537.525 : 621.396.611.4

3653. A cylindrical cavity filled with a d.c. discharge. G. W. STUART, JR. AND P. ROSEN. Letter in *J. Appl. Phys.*, **22**, 236 (*Feb.*, 1951).

Expressions for resonant frequency and Q-factor are given.

538.566

3654. Note on diffraction by an edge. D. S. JONES. *Quart. J. Mech. Appl. Math.*, **3**, 420–34 (*Dec.*, 1950).

On the assumption that electric current and charge on a perfectly conducting sheet are integrable near the edge, it is shown that the line distributions of current and charge on the edge are determined by the boundary conditions on the sheet. As a boundary condition on the edge it is postulated that there be no line distributions of magnetic current and charge; it is shown that the field is then uniquely determined. It is proved that, if the currents near the

edge can be expanded in power series, the index of the first term is $(2p + 1)/2$, where p is an integer, and $p > -2$ or > -1 according as the current parallel or perpendicular to the edge is considered. The diffraction, in 3 dimensions, of a plane wave by a semi-infinite plane is obtained. A.

538.566 : 535.13

The reflection of an electromagnetic plane wave by an infinite set of plates. *See Abstr.* 3422

538.566 : 537.533.7 : 621.392.2 : 621.385.1.029.6

3655. Transmission-line equivalent of electronic traveling-wave systems. W. E. MATHEWS. *J. Appl. Phys.*, **22**, 310–16 (*March*, 1951).

The small-signal behaviour of long electron beams may be analysed in terms of propagating space-charge waves, suggesting an equivalence between such beams and longitudinally moving transmission lines. This in turn suggests the analysis of such electronic devices as the travelling-wave amplifier, double-stream or electron-wave amplifier, and multicavity magnetron, in terms of coupled distributed-parameter transmission lines moving relative to each other. It is shown that this approach is equivalent to a rigorous field-theory analysis in certain cases of particular interest, and the procedure for calculating the significant distributed parameters is indicated. Final results for the idealized helix and thin cylindrical electron beam are presented. A.

538.566 : 621.392.2 : 621.396.11

3656. A note on reflection and transmission. B. A. LENGYEL. *J. Appl. Phys.*, **22**, 263–4 (*March*, 1951).

The quantities characterizing wave propagation through the interface of two media or through a transmission line containing obstacles are the two reflection coefficients r_1 and r_2 and the two transmission coefficients t_1 and t_2. It is shown that for any lossless discontinuity $|r_1| = |r_2|$, $\arg t_1 = \arg t_2$, and that $\arg r_1 + \arg r_2 - 2\arg t_1 = \pm\pi$. These relations are applied to the calculation of reflections from sheets of dielectric and metal-plate media, the latter being distinguished by the fact that $\arg t_1 \neq 0$. A.

538.566 : 621.396.11

3657. The scattering of radio waves. W. DIEMINGER. *Proc. Phys. Soc., Lond. B*, **64**, 142–58 (*Feb.*, 1951).

A review of the recent work on scattering draws attention to a number of discrepancies in the interpretation of the data. Most workers believe that the scattering is due to clouds in the E layer. The experiments described indicate that there are several types of scattering phenomena. It is concluded that the most common source of scatter is the reflection of waves from irregularities on the surface of the earth. In this case the wave path is from the transmitter to F layer—earth—F layer and hence to receiver, i.e. is analogous to a $2\times F$ reflection. The characteristics of the different types of scattering and their effects on the propagation of short waves are discussed. A.

538.566 : 621.396.11

3658. Reflection and transmission at the surface of metal-plate media. B. A. LENGYEL. *J. Appl. Phys.*, **22**, 265–76 (*March*, 1951).

The theory of Carlson and Heins has been extended; an expression is found for the reflection coefficient applicable in the presence of a diffracted beam. Tables and graphs are included for the coefficients associated with electromagnetic phenomena at the surface of metal-plate media. The magnitude of the reflection coefficient was measured at normal incidence and the phase of the transmission coefficient for angles of incidence from 0 to 25°. A satisfactory agreement with theory is obtained. A.

538.566 : 621.396.11

3659. Experimental determination of the reflection coefficient of metal-plate media. J. RUZE AND M. YOUNG. *J. Appl. Phys.*, **22**, 277–8 (*March*, 1951).

A method of measuring the reflection coefficient of metal-plate media at 3 cm is described. The technique differs from that presented in the preceding Abstr. in that the measurements are made in a closed system and back reflections are eliminated by an absorbing wedge. Angle of incidence and the plate thickness are varied. The agreement with the Carlson–Heins theory is excellent for very thin plates. For plates of moderate thickness near normal incidence the measured reflection is higher than that predicted for an infinitely thin set of plates with identical index of refraction. A.

538.566 : 621.396.671

3660. Diffraction of electromagnetic centimetre-waves at circular metallic disks. H. SEVERIN. *Z. angew. Phys.*, **2** (*No.* 12) 499–505 (1950) *In German.*

Aluminium disks of thickness 2 mm are subjected to waves of $\lambda = 10$ cm. Diameters of λ to 4λ are used. Propagation is perpendicular to the plane of the disk. The electric field-strength is measured along the centre normal and the resulting interference pattern compared with three approximate solutions of Maxwell's equations. It is found that the behaviour of the disk is adequately explained when replaced by a magnetic dipole. This is compared with the electric representation of a circular hole in a conducting sheet (Babinet's principle). In the mathematical development the alternate representation of a magnetic dipole by two electric dipoles is discussed. S. C. DUNN (R)

538.566 : 621.3.011 : 621.392.26

3661. The behaviour of electromagnetic waves in strongly inhomogeneous conduction paths. H. MEINKE. *Z. angew. Phys.*, **2** (*No.* 12) 473–8 (*Dec.*, 1950) *In German.*

The theory developed in earlier papers [Abstr. 3281 (1950)] is applied first to guiding surfaces of constant curvature and then to inhomogeneities of more general form. The appearance of longitudinal electric components produces characteristic wedge-shaped disturbances in the electric field. A. H. W. BECK (R)

538.566.2

3662. The interpretation of the magneto-ionic theory. K. C. WESTFOLD. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 152–86 (1951).

Some notable features of the Appleton–Hartree formula when collisions are neglected lead to a study of particular approximate solutions of the quadratic equation that determines the complex refractive index and the polarization. The most fruitful approximation is applicable when the collision frequency is small compared with the wave frequency. The solutions then provide sufficient data for a set of curves, presenting a complete mathematical picture of the

associated complex dielectric constant and the polarization, to be drawn. From these are derived curves depicting the behaviour of the refractive index and absorption coefficient under physical conditions. Other approximations include the cases of the gyro-frequency small and large compared with the wave frequency, and the collision frequency large compared with the wave frequency. Applications of the magneto-ionic theory to propagation in the solar atmosphere are critically discussed and formulae for the emergent intensity of thermal radiation whose frequency is large compared with the gyro-frequencies of the medium are given. A.

538.566.2

3663. The theory of metal plates dielectric. T. SAKURAI. *J. Phys. Soc. Japan*, **5**, 389–93 (*Nov.–Dec.*, 1950).

Electromagnetic waves incident on the inclined boundary of a group of parallel metal plates separated from one another by distances which are small compared with a half-wavelength, behave in a similar manner to visible light incident on polarizing material. The macroscopic boundary conditions derived from Maxwell's field equations hold even when the permittivity and permeability vary near the boundary plane of the metal plates dielectric. If a plane electromagnetic wave is incident on the boundary plane, angles of incidence and of reflection are equal. The law of refraction of the transmitted wave is complementary to Snell's law. J. H. MASON

538.566.2

3664. Radio reflexions from a column of ionized gas. D. ROMELL. Letter in *Nature, Lond.*, **167**, 243 (*Feb.* 10, 1951).

Note on observations of reflection of 30 cm radio waves from a Hg discharge tube of dia. 3 cm and length 80 cm. Plotting amplitude of reflected signal as a function of discharge current shows multiple resonance peaks. W. J. G. BEYNON

538.566 : 621.392.26

3665. Cut-off frequency in two-dielectric layered rectangular waveguides. J. VAN BLADEL AND T. J. HIGGINS. *J. Appl. Phys.*, **22**, 329–34 (*March*, 1951).

Equations for the modes and eigenvalues of two-dielectric-layered rectangular waveguides are derived. From these equations are plotted graphs of cut-off frequency over a range of geometric and dielectric parameters sufficiently wide to cover most requirements of design. A.

538.566.2 : 621.396.11

3666. Investigations on the influence of the troposphere on the propagation of ultra-short waves. R. SCHACHENMEIER. *Arch. elekt. Übertragung*, **5**, 1–9 (*Jan.*, 1951) *In German.*

The treatment is mainly theoretical and is a consideration of the effect of refraction both within and outside the optical horizon for wavelengths of 1 to 10 m. J. M. HOUGH (R)

538.566.2 : 621.396.11

3667. The waveforms of atmospherics and the propagation of very low frequency radio waves. P. W. A. BOWE. *Phil. Mag.*, **42**, 121–38 (*Feb.*, 1951).

The responses of narrow-band receivers to individual radio atmospherics have been observed in order to describe the propagation of radio waves of frequency 2 kc/s to 10 kc/s over the surface of the earth. It has been found that the atmospherics from a fixed distance are sufficiently uniform to enable the relative attenuations of different frequencies to be deduced. The study reveals that waves of frequency below about 8 kc/s are heavily attenuated during the daytime but are propagated freely at night. The attenuation is greater during a sudden ionospheric disturbance. These results confirm and extend those obtained recently by Gardner. They can be explained in outline on a theory recently proposed by Budden. [Abstr. 2863 (1951)]. A.

538.566.3

3668. The ray path in a curved ionospheric layer. K. BIBL. *Rev. Sci., Paris*, **88**, 27–9 (*Jan.–March*, 1950) *In French.*

An analysis is made of the magnitude of the 1st- and 2nd-order approximations usually involved in calculations for the ray path in a curved "parabolic" ionospheric layer. W. J. G. BEYNON

538.566.3

3669. Ionospheric reflection of very long radio waves. J. P. STANLEY. *Canad. J. Res. A*, **28**, 549–57 (*Nov.*, 1950).

A simplified model of the long-wave-reflecting region of the ionosphere, first considered in a previous paper [Abstr. 2870 (1951)] is used to calculate the theoretical variation of sky wave reflection coefficient with angle of incidence and with the angle of dip of the earth's magnetic field. The resulting curves are found to be in good agreement with experiment. They lead to the conclusion that theoretical results based on the assumption of a vertical magnetic field will not lead to errors in vertical incidence sky wave reflection coefficient greater than about 10%, even though the field is inclined at an angle of as much as 23° to the vertical. A.

538.566.3 : 551.510.535 : 621.396.11

3670. Some further investigations of ionospheric cross-modulation. I. J. SHAW. *Proc. Phys. Soc., Lond. B*, **64**, 1–20 (*Jan.*, 1951).

Continuation and development of experiments [Abstr. 2511 (1948)]. Measurements of the phase and amplitude of the modulation transferred to an unmodulated wave by a modulated disturbing wave in the ionosphere are used to provide information about that part of the ionosphere in which the cross-modulation occurs. By measuring almost simultaneously the height of reflection of the wanted wave and the characteristics of the transferred modulation, a value of $1{\cdot}4\times10^6$ per sec for the collision frequency of electrons with molecules at a height of 92 km has been deduced. This measurement has been made possible by the use of a very sensitive automatic apparatus which is briefly described. Special attention has been paid to the "gyro-resonance effect" in cross-modulation. The experiments appear to show that the predicted enhancement of the cross-modulation when the disturbing station radiates on the local gyro-magnetic frequency does not exist. A modification of the original theory is given which is of great use in the calculation of the cross-modulation to be expected for a given pair of transmitters. This

modified theory is used in the discussion of the gyro-resonance effect and of the observed decrease of the cross-modulation at dawn. The agreement between the calculated and observed magnitudes of cross-modulation is stressed in view of the fact that the calculations involve a knowledge of the absorption of the wanted wave incident obliquely upon the ionosphere. A.

MAGNETIC EFFECTS 538.6

538.614

3671. Evidence for magnetic rotatory polarization at a frequency of 3 000 Mc/s. J. Soutif-Guicherd and M. Lambinet. *C.R. Acad. Sci., Paris*, **231**, 1460–2 (*Dec.* 18, 1950) *In French.*

An experimental arrangement is described for accurate measurement of the rotation of polarized electromagnetic waves by a paramagnetic salt in uniform magnetic fields. The Landé factor, g, of anhydrous $MnSO_4$ is found to be $+ 1{\cdot}96$.

W. R. ANGUS

538.632

3672. The Hall effect in indium. E. S. Borovik. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 639–41 (1950) *In Russian.*

The Hall and magnetoresistance effects of In at and below 20·4°K are given in the form of graphs as functions of the magnetic field. D. H. WHIFFEN

538.639

3673. The theory of Goldhammer's phenomenon in ferromagnetics. S. V. Vonsovskiĭ and K. P. Rodionov. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 643–6 (1950) *In Russian.*

Theoretical. The nature of the forces responsible for the Goldhammer effect (the change of electrical resistance in ferromagnetic crystals) has hitherto been obscure. In order to explain these forces a model proposed previously [*J. Exp. Theor. Phys.*, **16**, 981 (1946)] is used, in which the electrons of a ferromagnetic crystal which determine its magnetic, electrical and other physical properties are conventionally divided between the inner *S*-electrons and the external *d*-electrons, between which there exists electrical (volume) and magnetic (spin and spin orbital) interaction. It is proposed that ferromagnetic properties are fundamentally determined by the internal electrons, and electrical properties by external electrons. Equations are deduced which indicate that the Goldhammer effect is completely determined by the magnitude of the spontaneous magnetization and not by external magnetic field. The external field is only responsible for the initial orientation of the spontaneous magnetization.

W. HUGHES

538.652

3674. Law governing the even effects when approaching saturation, the internal elastic tensions being taken into account. G. I. Dyakov. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 2) 201–4 (1951) *In Russian.*

Contains the calculation of (1) magnetostriction of a monocrystal in strong magnetic fields, the elastic tension being taken into account; (2) magnetostriction of a polycrystalline ferromagnetic body when approaching the saturation state, the diffuse tensions being taken into account; and (3) law of approaching saturation for even effects when the direction of the deforming force coincides with that of the external magnetic field. F. LACHMAN

538.69

3675. Apropos two papers by Ehrenhaft and Herzog. Is a uniform magnetic field capable of accelerating the radiation emitted by radium-E? E. Cotton, P. Tauzin and B. Tsai. *C.R. Acad. Sci., Paris*, **232**, 44–6 (*Jan.* 3, 1951) *In French.*

Polemical against Ehrenhaft and Herzog [Abstr. 4104 (1949)]. The intensity of the blackening on a photographic plate by the passage of the radiation from RaE through an Al plate (2–3 mm thick) in a magnetic field has been investigated at different field strengths and the effect is considered to arise from short-lived X-radiation produced by the action of β-rays on Al. W. R. ANGUS

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 539.4.01

3676. Intrinsic crystalline structure and the strength of metals. W. A. Wood. Letter in *Phil. Mag.*, **42**, 310–12 (*March*, 1951).

The "block-structure" theory of Fürth [Abstr. 1895 (1950)] is defended against the criticism of Paterson [Abstr. 5322 (1950)].

539.11 : 539.4.01 : 669.018

3677. The cohesion of alloys: I. Intermetallic systems formed by copper, silver and gold, and deviations from Vegard's law. M. A. Jaswon, W. G. Henry and G. V. Raynor. *Proc. Phys. Soc., Lond. B*, **64**, 177–89 (*March*, 1951).

In order to extend the theory of the cohesion of metals to alloy structures a new treatment is considered. The excess energy of the solid solution, as compared with that of a mixture of the pure components, is estimated by considering that the introduction of a solute atom causes a major disturbance extending only to its nearest neighbours, and a less serious disturbance in the surrounding matrix. For a face-centred cubic structure, therefore, attention is directed to the group of thirteen atoms formed by the solute atom and its twelve symmetrically situated solvent atoms. The size of the atomic polyhedra forming this group is different from the sizes of the polyhedra in the solvent matrix, and the equilibrium size of the polyhedra within the group is calculated from the known lattice energies of the components, the atomic radii of the components, and the strain energy introduced into the matrix, which is a measure of the long-range minor disturbance. Using these conceptions, the deviations from Vegard's law to be

expected in the solid solutions formed by Cu, Ag and Au taken in pairs are evaluated. The sign of the deviation is correctly predicted in all cases; quantitative agreement between the magnitudes of the expected and observed deviations is obtained for the Cu–Ag alloys, which provide the most favourable case for treatment. Application of the theory to problems of solid solution formation is briefly discussed. In its present form the theory applies only to dilute solid solutions. A.

539.11 : 539.4.01 : 669.018

3678. The cohesion of alloys: II. Some general metallurgical implications. W. G. HENRY, M. A. JASWON AND G. V. RAYNOR. *Proc. Phys. Soc., Lond. B*, **64**, 190–4 (*March*, 1951).

On the basis of the theory developed in the first paper of this series, certain phenomena of general theoretical interest may be interpreted. The theory indicates that, for cases of mutual solid solubility of the two components of a binary alloy, the wider solution should be formed where the smaller ion is dissolving in the solvent with the larger ion. This is in agreement with observation. The theory also interprets adequately the observation that, in general, the less compressible of a given pair of metals tends, at a given temperature, to dissolve more of the metal with the higher compressibility than the reverse. The possible effect on solid solubility relationships of the mutual distortion of the electron clouds of the component ions in a binary alloy is also discussed from the point of view of the theory, and it is concluded that such distortion effects are insufficient to account for the difference between the equilibrium diagrams for the Cu–Au and Cu–Ag alloys. It is suggested that mutual distortion of the ions is not an important effect for the alloys formed by metals in Group IB of the Periodic Table, taken in pairs. For alloys containing small ions bearing a high charge, however, this factor may still be of importance. A.

539.11 : 539.4.01 : 669.018

3679. The cohesion of alloys: III. Extension to high solute concentrations, and application to the alloys of group IA metals. W. G. HENRY AND G. V. RAYNOR. *Proc. Phys. Soc., Lond. B*, **64**, 195–206 (*March*, 1951).

The theory [preceding Abstr.] permits an estimate to be made, in dilute solution, of the extra energy Δ_{12} associated with the solution of metal 2 in metal 1 to form an alloy. In order to apply this theory to problems of solid solution formation, it is necessary to extend it to cover cases of relatively concentrated solution, when the variation of Δ_{12} with composition must be considered. A reasonable extension is discussed in the present paper, making the assumption that Δ_{12} varies linearly with composition. It is shown that if Δ_{12} is large, limited solid solution formation is to be expected, while if Δ_{12} is small, extensive or complete solid solution formation is possible. Calculations made for the alloys of the alkali metals, taken in pairs, give results in good agreement with experiment, and interpret the fact that solid solution formation is restricted in all the possible systems except K–Rb, K–Cs and Rb–Cs, for which extensive solid solutions exist. Further extension of the theory to include the liquid state enables the relative magnitudes of the liquidus depressions in the systems K–Rb, K–Cs, Rb–Cs, Na–K, Na–Rb and Na–Cs to be accounted for, and also interprets the compositions of the eutectic points in the systems Na–K, Na–Rb and Na–Cs. The formation of immiscible liquid systems is also discussed. A.

539.11 : 541.57

3680. The structure of hardmetals. P. SCHWARZKOPF. *Powder Metall. Bull.*, **5**, 68–79 (*Dec.*, 1950).

The author suggests that in establishing a theoretical basis for new development work in the hardmetal field emphasis should be shifted from crystal structure to bond structure. Certain concepts of Pauling's resonating-valence-bond theory suggest that this theory is particularly suited as a starting-point for the theoretical treatment of the bond structure of hardmetals. H. P. MYERS

539.11 : 548.7

3681. A quantum mechanical treatment of the lithium fluoride crystal. G. C. BENSON AND G. WYLLIE. *Proc. Phys. Soc., Lond. A*, **64**, 276–82 (*March*, 1951).

A simplified quantum-mechanical model for the LiF crystal is described. The lattice parameter, cohesive energy and compressibility are calculated using three different choices of wave function for the F ion in the crystal; these are (i) the Hartree wave functions for the free ion F^-; (ii) wave functions orthogonalized to the 1*s*-orbitals of the six nearest neighbour Li ions; (iii) functions similar to (ii), but based on wave functions for the free ion which have been contracted to give agreement with the diamagnetism of F^-. The results obtained in (i) are in fair agreement with the empirical values. Large discrepancies are observed when the more complete wave functions (ii) are employed. This is taken as indicating that the Hartree wave functions for the free ion are too diffuse and the results of the third calculation, which agree well with experiment, substantiate this interpretation. A.

MOLECULAR STRUCTURE 539.13

539.132

3682. On the anomalously great decay time for some dipolar emitted radiations. E. I. ADIROVICH. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 366–70 (1950) *In Russian.*

In quantum mechanics the decay time for emission of radiation from excited molecules is given by $3\hbar c^3/(4\omega^3|D_{mn}|^2)$ where D_{mn} is the transition moment and ω the angular frequency. This time may be as long as 10^{-3} sec for dipolar transitions if D_{mn} is small, and this means that the characterization of such long times as necessarily due to quadrupole transitions is unreliable. D. H. WHIFFEN

539.132

3683. Complete molecular orbital treatment of the system H_4. R. TAYLOR. *Proc. Phys. Soc., Lond. A*, **64**, 249–60 (*March*, 1951).

A complete molecular orbital calculation has been made for the linear system of four protons with four

associated electrons. Results indicate the validity of the assumptions usually made in approximate calculations of this type. All the three- and four-centred integrals usually neglected in such work have been evaluated and found to be of great importance in determining the energy levels of the system. A.

539.132 : 541.57

3684. The molecular orbital theory of chemical valency. VII. Molecular structure in terms of equivalent orbitals. G. G. HALL AND J. LENNARD-JONES. *Proc. Roy. Soc. A*, **205**, 357–74 (*Feb.* 22, 1951).

See Abstr. 7417 (1950) for Part VI. The twofold method of describing molecular structure, developed in earlier parts, is applied to a number of simple molecules to elucidate various properties of chemical interest. CH_4, NH_3, H_2O and HF are used to illustrate the properties of lone pairs of electrons and to show the significance of tetrahedral orbitals. Ethylene provided an example of the dual way of describing a double bond, either as a σ bond and a π bond, or as two equivalent bonds. The triple bonds of acetylene and N are similarly discussed, and an answer sought to the question why the lone pair of electrons on each atom of the N molecule differ from that of NH_3. Butadiene and benzene are considered as examples of conjugated systems in order to bring out the unlocalized character of the equivalent orbitals used to describe them, thus illustrating an essential difference between saturated and unsaturated molecules. There is also a short discussion of the boron hydrides and cyclopropane, each of which present some unusual features. A.

539.132 : 541.57

3685. The molecular orbital theory of chemical valency. VIII. A method of calculating ionization potentials. G. G. HALL. *Proc. Roy. Soc. A*, **205**, 541–52 (*March* 7, 1951).

See Abstr. 3684 (1951) for Part VII. An analysis of the "linear combination of atomic orbitals" approximation using the accurate molecular orbital equations shows that it does not lead to equations of the form usually assumed in the semi-empirical molecular orbital method. A new semi-empirical method is proposed, therefore, in terms of equivalent orbitals. The equations obtained, which do have the usual form, are applicable to a large class of molecules and do not involve the approximations that were thought necessary. In this method the ionization potentials are calculated by treating certain integrals as semi-empirical parameters. The value of these parameters is discussed in terms of the localization of equivalent orbitals and some approximate rules are suggested. As an illustration the ionization potentials of the paraffin series are considered and good agreement between the observed and calculated values is found. A.

539.133

3686. Rotational magnetic moments in polyatomic molecules. C. K. JEN. *Phys. Rev.*, **81**, 197–203 (*Jan.* 15, 1951).

There is generally present in a molecule a small magnetic moment associated with its rotational degree of freedom. The rotational g-factor can be measured by an experimental method based upon the Zeeman effect. Previously, the most successful measurements have been made with the molecular beam resonance technique. More recently, the microwave Zeeman splitting of molecular rotation lines has offered another method for the determination of rotational g-factors. With this method, the g-factors of several molecules such as NH_3, H_2O, OCS, etc., have been measured. The quantum mechanical theory of the rotational magnetic moment of the symmetric top molecule has been developed, and the experimental results are discussed qualitatively in the light of this theory. A.

539.133 : 535.343

3687. Vibration spectrum and force constants of diacetylene. M. A. KOVNER AND V. T. SALOSIN. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 651–4 (1950) *In Russian.*

Frequencies are calculated from a valence force field which includes interactions of neighbouring bonds and of adjacent angles. A comparison with known frequencies yields the corresponding force constants. J. JACOBS

539.133 : 538.614

3688. Magnetic rotatory power of tetranitromethane. Rotativity of the C–NO_2 link. R. DE MALLEMANN AND F. SUHNER. *C.R. Acad. Sci., Paris*, **231**, 1389–90 (*Dec.* 18, 1950) *In French.*

Comparison of the bond rotativities in tetranitromethane and in nitromethane suggests that the NO_2 group decreases the rotativities of neighbouring C–H groups in the molecule. W. R. ANGUS

539.133 : 538.614

3689. Magnetic rotatory power and constitution of hydrogen peroxide. F. GALLAIS AND R. WOLF. *C.R. Acad. Sci., Paris*, **231**, 1458–60 (*Dec.* 18, 1950) *In French.*

The specific and molecular magnetic rotatory powers of 7 solutions of H_2O_2 are tabulated for 3 wavelengths. The results are in accord with the structure H–O–O–H. W. R. ANGUS

539.133 : 541.124

3690. Empirical methods of estimating resonance energies. I. Annelation energy. R. D. BROWN. *Trans Faraday Soc.*, **46**, 1013–18 (*Dec.*, 1950).

A molecular-orbital quantity termed the annelation energy is introduced to facilitate the empirical estimation of resonance energies of aromatic systems. The annelation energy is the loss in resonance energy accompanying annelation of two aromatic systems to produce a third. It is shown to be simply related to the mobile orders of the two bonds undergoing fusion. The statistics of the relationship are investigated and some resonance energies calculated by this method are listed. A.

539.133 : 541.57

3691. The non-planar vibrations of some substituted ethylenes and related compounds. P. TORKINGTON. *Proc. Roy. Soc. A*, **206**, 17–39 (*March* 22, 1951).

By applying a general normal co-ordinate treatment to the non-planar group of vibrations of related series of substituted ethylenes, it has been found possible to obtain consistent sets of force constants for the non-planar bending motions, and to correlate their variation with the observed shifts in the group frequencies

and with the electro-negativities and electron-donating powers of the substituents. From calculations on twelve compounds, a linear relation between the CH_2= bending constant, (f_{CH_2}), and the corresponding group frequency (δ_{CH_2}) is obtained and used to fit a further nine compounds into the series. The results can be extended to include related unsaturated compounds. The relatively high value of f_{CH_2} in formaldehyde can be related to the fact that this molecule is a resonance hybrid in which the ionic structure CH_2^+—O^- is of considerable importance. The low value of f_{CH_2} in allene suggests that this is also a resonance hybrid, with contributions from ionic structures CH_2^-—C^+=CH_2. In the allyl halides, the resonance effect is inhibited by the CH_2 group, and the order of the frequencies is the reverse of that in the vinyl halides. The resonance effect cannot operate directly on the odd =C—H bond in CH_2=CHX; the bending constant f_{CH} decreases as the electronegativity of the substituent X increases, —CN now lying between CH_3 and Cl and the effect again being particularly large for fluorine. The values of f_{CH} in acetylene and benzene (non-planar) suggest that there may be an inverse relation between the constants for C—C stretching and for bending of the adjacent C—H bonds. A.

539.133 : 541.57

3692. Consonant electron systems. G. STEIN. *Naturwissenschaften*, **37** (*No.* 24) 560–1 (1950) *In German.*

Introduces the conception of "consonance," i.e. the special condition of maximum resonance in electron systems having a definite number of electrons. The "consonant electron systems" are numerically alternately increasing electron systems having maximum values of the "specific" energy of mesomerism. The idea of consonant electron systems is used for explaining the physico-chemical behaviour of benzene and simple aromatic compounds. F. LACHMAN

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

3693. Chemical binding of the proton measured with a slow neutron velocity selector. R. KELLER. *Helv. Phys. Acta*, **23** (*No.* 6–7) 627–50 (1950) *In French.*

The scattering cross-section for H is measured as a function of energy, for neutron energies between 0·003 and 1 eV, in order to study the nature of the H bond in different types of binding. The substances examined are $(COOH)_2$, HCOONa, HCOOH, $CuSO_4 . 5H_2O$ and H_2O. The D–D reaction is used with a linear accelerator working at 200 kV. The cross-section of B is measured as a control.

J. THEWLIS

539.152.1

3694. Statistical model of nuclear shells. D. IVANENKO AND V. RODICHEV. *Guide Russ. Sci. Period. Lit.*, **3**, 313–16 (*Nov.*, 1950).

Full English translation of article abstracted in Abstr. 5199 (1950).

539.152.1

3695. The nuclear spin of $_{43}Tc^{99}$. K. G. KESSLER AND W. F. MEGGERS. Letter in *Phys. Rev.*, **80**, 905–6 (*Dec.* 1, 1950).

The hyperfine structure of the 4 238·19 Å emission line of technetium was determined on a 2·1 mg sample of Tc^{99} using a Fabry–Perot interferometer, and indicates that the spin of Tc^{99} is $9\hbar/2$.

A. O. STANESBY

539.152.1

3696. Evidence concerning equality of *n–n* and *p–p* forces. G. BREIT. Letter in *Phys. Rev.*, **80**, 1110–11 (*Dec.* 15, 1950).

Comparison of the angular distributions of neutrons (4·5 and 5·5 MeV) and of protons (5·25 MeV) scattered by deuterons, after consideration of the effect of Coulomb forces in the latter case, supports the evidence derived from Coulomb energies of light nuclei that *n–n* and *p–p* forces are equal.

R. H. DALITZ

539.152.1

3697. Binding energy of the triton. R. L. PEASE AND H. FESHBACH. Letter in *Phys. Rev.*, **81**, 142–3 (*Jan.* 1, 1951).

Variational treatment using a mixture of tensor and central forces, designed to utilize properties of H^3, in preference to nucleon scattering data, for fixing parameters in force laws. J. R. MADDOX

539.152.1

3698. On the determination of reduced widths from the one-level dispersion formula. R. G. THOMAS. Letter in *Phys. Rev.*, **81**, 148–9 (*Jan.* 1, 1951).

The usual approximation of neglecting the variation of the level shift with respect to the energy of the incident particle may be unjustified for broad levels. The correction is significant in the 456 keV resonance of the $C^{12}(p\gamma)$ reaction. For *s*-wave neutron reactions no correction arises. A general criterion for the applicability of the correction cannot be given; probably it is important for resonances with $\gamma^2 \gtrsim \hbar^2/10$ Ma. J. JACOBS

539.152.1

3699. On the existence of a one-MeV energy level in C^{13}. M. BLUNDELL AND J. ROTBLAT. Letter in *Phys. Rev.*, **81**, 144 (*Jan.* 1, 1951).

539.152.1

3700. Remarks on the values of nuclear radii deduced from α-radioactivity. G. AMBROSINO AND H. PIATIER. *C.R. Acad. Sci., Paris*, **232**, 400–1 (*Jan.* 29, 1951) *In French.*

It is shown that the screening of the Coulomb field near the nucleus of heavy atoms as treated by the Thomas–Fermi method leads to a reduction of the Gamow barrier against α-particle emission by ~ 36 keV. An effect of the same order of magnitude is the difference between the total binding energy of the electrons in the initial and final nucleus which should also be included in the energy balance. The two effects account for the empirical anomaly of 3–4% in the radii of U^{238} and Th^{232} (being relatively more important in these cases because of the low α-particle energies). W. J. SWIATECKI

539.152.1

3701. The nuclear surface energy. W. J. SWIATECKI. *Proc. Phys. Soc., Lond. A*, **64**, 226–38 (*March*, 1951).

The kinetic and potential parts of the nuclear surface energy are calculated on the basis of the statistical model of the nucleus taken to first order and using a Gaussian interaction between particles. The resulting surface energy is found to be of the right order of magnitude, the calculated figure being in fact 55% of the empirical value.

539.152.2

3702. The diamagnetic correction for protons in water and mineral oil. H. A. THOMAS. Letter in *Phys. Rev.*, **80**, 901–2 (*Dec.* 1, 1950); erratum, **81**, 643 (*Feb.*, 1951).

Measurements of the proton nuclear resonance shifts are reported. The actual shifts from H_2 gas are $\Delta H/H = +1{\cdot}6\times10^{-6}$, $-0{\cdot}6\times10^{-6}$ for oil and H_2O resp., leading to diamagnetic corrections $\delta(\text{oil}) = 28{\cdot}4\times10^{-6}$, $\delta(H_2O) = 26{\cdot}2\times10^{-6}$. The comparison of the standard sample used for the proton gyromagnetic ratio with H_2 gas suggests corrected values as follows: $\gamma = (2{\cdot}67530 \pm 0{\cdot}00006)\times 10^4$ sec^{-1} gauss^{-1}, $e/m = (1{\cdot}75891 \pm 0{\cdot}00005)\times10^7$ e.m.u. gram^{-1}. J. JACOBS

539.152.2

3703. The electric quadrupole moment of Li^6. N. A. SCHUSTER AND G. E. PAKE. Letter in *Phys. Rev.*, **81**, 157–8 (*Jan.* 1, 1951).

Quadrupole splitting of the Li^6 and Li^7 magnetic resonances was obtained from a natural single crystal of $LiAl(SiO_3)_2$. For the uncompletely resolved Li^6 resonances, absorption curves were obtained by graphical integration of the experimentally measured derivatives. The ratio of the quadrupole moments Q_6/Q_7 was found to be $0{\cdot}023 \pm 0{\cdot}002$. Using Kusch's value for Q_7 [see Abstr. 417 (1950)] one deduces $Q_6 = 4{\cdot}6\times10^{-28}$ cm^2. L. PINCHERLE

539.152.2

3704. The electric quadrupole moment and the magnetic moment of the bromine nucleus. J. D. RANADE. *Phil. Mag.*, **42**, 279–83 (*March*, 1951).

Deviations from the interval rule have been observed in the hyperfine structure of the bromine arc spectrum. These are attributable to an electrical quadrupole moment of the bromine nucleus. Coupling constants are determined for the term involved. The nuclear quadrupole moment is calculated to be $0{\cdot}28\times10^{-24}$ cm^2, and the magnetic moment 1·8 nuclear magnetons. A.

539.152.2

3705. Quadrupole moments and the nuclear shell model. B. TOUSCHEK. *Phil. Mag.*, **42**, 312–14 (*March*, 1951).

The nuclear shell model [Abstr. 7193 (1949), 538 (1951)] makes certain predictions about the quadrupole moments of a certain category of odd nuclei, which are shown to be on the whole in good agreement with experiment. See also Abstr. 1911, 6006–7 (1950).

539.153

3706. Effects of nuclear motion on the fine and the hyperfine structure of hydrogen. T. ISHIDZU. Letter in *Progr. Theor. Phys.*, **5**, 904 (*Sept.–Oct.*, 1950).

539.153

3707. Secondary electron emission and atomic shell structure. E. J. STERNGLASS. Letter in *Phys. Rev.*, **80**, 925–6 (*Dec.* 1, 1950).

The true secondary electron yield Δ_m, obtained by subtracting from the total yield the high-energy back-scattered electrons, increases steadily as long as successive shells are filled without leaving an inner shell incomplete. Δ_m decreases discontinuously when a new shell is begun, whether the inner shells are complete or incomplete, and two parallel sets of lines are obtained for complete and incomplete inner shells. J. HUGHES

539.153 : 535.332

3708. Fine structure of the hydrogen atom. II. W. E. LAMB, JR. AND R. C. RETHERFORD. *Phys. Rev.*, **81**, 222–32 (*Jan.* 15, 1951).

In the first paper [Abstr. 554 (1951)] the shift of the $2^2S_{\frac{1}{2}}$ level of H was determined to be 1 000 Mc/s. A new apparatus differing from the original one in details, but not in principle, has been built in order to improve the accuracy of the above result. This provides a greater yield of metastable H atoms, a more homogeneous magnetic field, and more accurate means of measurement of magnetic field and frequency. With these improvements, preliminary measurements of considerably increased accuracy have been made on both H and D. The transitions observed were $2^2S_{\frac{1}{2}}$, $m = \frac{1}{2}$, to $2^2S_{\frac{1}{2}}$, $m = -\frac{1}{2}$, as well as to $2^2P_{\frac{1}{2}}$, $m = \frac{1}{2}$ and $m = -\frac{1}{2}$. The first transition permits observation of the hyperfine structure of $2^2S_{\frac{1}{2}}$, as well as an accurate calibration of magnetic field. Hyperfine structure was also resolved for the last transition in H. There was no observable difference between the level shifts for H and D which may be taken as $1\,062 \pm 5$ Mc/s. Later papers of this series will deal with the numerous experimental and theoretical corrections necessary to obtain a level shift accurate to 1 Mc/s. A.

539.153 : 535.332

3709. A remark on the calculation of the Lamb shift. L. HANSSON AND H. E. V. HÅKANSSON. *Ark. Fys.*, **2**, *Paper* 43, 459–60 (1950).

The small result of an approximation due to Bethe is estimated. J. R. MADDOX

539.153 : 535.332

3710. On the effect of electric fields on the life-time of the metastable states of hydrogen. G. LÜDERS. *Z. Naturforsch.*, **5a**, 608–11 (*Nov.*, 1950) *In German.*

The $2S_{\frac{1}{2}}$ to $1S_{\frac{1}{2}}$ transition is considered, and the complication of the Lamb-shift effect discussed. J. R. MADDOX

539.153 : 535.337

3711. Variations of the factor "g" in the partial Paschen–Back effect. M. A. CATALÁN AND R. VELASCO. *An. Real Soc. Esp. Fis. y Quim.*, **47**, 7–14 (*Jan.–Feb.*, 1951) *In Spanish.*

Following previous work [Abstr. 8918 (1950), 1721 (1951)] a table is given for use in calculating the perturbations due to the partial Paschen–Back effect. A.

539.153 : 539.172.13

3712. Excited state of Be^9 from the $B^{11}(d, \alpha)Be^{9*}$ reaction. D. M. Van Patter, A. Sperduto, K. Huang, E. N. Strait and W. W. Buechner. *Phys. Rev.*, **81**, 233–8 (*Jan.* 15, 1951).

The alpha-particles from B bombarded by 1·51 MeV deuterons have been investigated with a magnetic spectrometer. Two groups of alpha-particles have been assigned to the reaction $B^{11}(d, \alpha)Be^9$ with Q-values of $8·018 \pm 0·007$ and $5·596 \pm 0·006$ MeV, indicating a virtual state of Be^9 at $2·422 \pm 0·005$ MeV. The previously unreported alpha-particle group corresponding to this excited state had a natural half-width of less than 7 keV. No additional alpha-groups corresponding to excited states of Be^9 were observed for excitations of Be^9 from 0 to 5·0 MeV. A.

539.155.2

3713. Apparatus for concentration of He^3 by thermal diffusion. O. F. Schuette, Jr., A. Zucker and W. W. Watson. *Rev. Sci. Instrum.*, **21**, 1016–18 (*Dec.*, 1950).

A multistage thermal diffusion apparatus for the concentration of He^3 is described. Included is a novel 3-stage, all-metal column based on a G. E. Calrod heater. Concentration was carried only to a He^3/He^4 ratio of 0·05%, a factor of $3·3 \times 10^3$. The performance indicates the importance of having the hot wall in concentric cylinder columns made of metal of good thermal conductivity to minimize azimuthal temperature gradients which can markedly increase parasitic remixing of the gas if a metal such as stainless steel is used. A.

539.155.2

3714. The effect of mass discrimination on isotope abundance measurements. Relative abundances of krypton isotopes. O. A. Schaeffer. Letter in *J. Chem. Phys.*, **18**, 1681–2 (*Dec.*, 1950).

The calculations of electrostatic scanning errors by Coggeshall (*J. Chem. Phys.*, **12**, 19 (1944)] and Berry [Abstr. 8051 (1950)] show that systematic error should be absent with magnetic scanning, but are applicable only to mass spectrometers with simple ion sources. The natural abundances of the Kr isotopes have been measured, using electrostatic and magnetic scanning. The electrostatic scanning results show serious mass discrimination, but magnetic scanning, over a wide range of accelerating voltages, gives self-consistent results in agreement with those of Nier [Abstr. 6025 (1950)] obtained with the help of calibration mixtures. It should therefore be possible to rely on magnetic scanning measurements where calibration mixtures are not available.

T. G. PICKAVANCE

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 531.7

3715. The spatial location, from a distance, of an object marked by a γ-ray emitter (cobalt 60). P. Süe and P. Bélilovsky. *J. Phys. Radium*, **11**, 664–5 (*Dec.*, 1950) *In French.*

An object of 1 cm^3, marked by ~ 500 μc, of Co^{60} can be located in a volume of 10^5 cm^3, using moving counters with Pb collimators. In 1 min the object can be located in a 15 cm^3 sphere. In 5 min the location is very precise, 80 out of 100 times within the object. J. HUGHES

539.16.08

3716. Statistical distribution of the α-particles registered on a photographic plate as function of the projection of their path on the plane of the plate. G. Imbó and L. Casertano. *Ann. Geofis.*, **3**, 475–83 (*Oct.*, 1950) *In Italian.*

The distribution is deduced both for single elements and for radioactive families in equilibrium. These data are useful to determine the radioactive materials content of natural rocks. L. PINCHERLE

539.16.08

3717. A hands and feet contamination monitor. F. S. Goulding and K. E. G. Perry. *Atomics, Lond.*, **2**, 43–50 (*Feb.*, 1951).

A permanently installed monitor is discussed. Provision for the detection of α-, β- and γ-contamination is included and, as far as possible, the operation of the instrument is fully automatic to allow for use by unskilled workers. In the case of hands and feet, indication is given by meters showing integrated counts over a short period, with an alarm bell to give warning of excess dose. A counting rate meter having a roughly logarithmic scale and also loudspeaker indication are included for use with the clothing probes. A.

539.16.08 : 537.542

3718. Quantitative measurement of samples of tritium. J. H. Frisby and D. Roaf. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 169–71 (*Feb.*, 1951).

The design of counters and quenching arrangements for gaseous counting of T disintegrations, giving an absolute measurement of concentration, are described.

539.162 : 530.145

3719. On the angular correlation theorem. B. A. Lippmann. Letter in *Phys. Rev.*, **81**, 162–3 (*Jan.* 1, 1951).

A theorem simplifying the expression for angular correlation between successively emitted particles by choosing a suitable quantization axis, recently proved generally by Lloyd [Abstr. 1988 (1951)] is shown to be obvious from the physical interpretation of the quantum-mechanical formalism.

R. H. DALITZ

539.163

3720. The isomeric transition of Tc^{95}. H. A. Medicus and P. Preiswerk. Letter in *Phys. Rev.*, **80**, 1101–2 (*Dec.* 15, 1950).

The isotope Tc^{95} decays with two half-lives of 20 hr and 60 day [Abstr. 6707 (1950)]. The direct transition from the latter to the former has been observed by means of a magnetic lens spectrometer (39 keV conversion electrons). The estimated half-life of ~ 5 yr confirms an order of transition $\Lambda = 5$ (change of 4 units in angular momentum and change of parity).

W. J. SWIATECKI

539.163

3721. The new isotope Pu^{242} and additional information on other plutonium isotopes. S. G. Thompson, K. Street, Jr., A. Ghiorso and F. L. Reynolds. Letter in *Phys. Rev.*, **80**, 1108–9 (*Dec.* 15, 1950).

The α-particle energy of Pu^{240} is $5{\cdot}16 \pm 0{\cdot}02$ MeV, of Pu^{241} is $4{\cdot}91 \pm 0{\cdot}03$ MeV and of Pu^{242} is $4{\cdot}88$ MeV. The $T_{\frac{1}{2}}$ of Pu^{241} for β-decay is 14 yr, and the cross-section for the reaction $Pu^{241}(n, \gamma)Pu^{242}$ with pile neutrons ~ 250 barns. The α-decay $T_{\frac{1}{2}}$ for Pu^{242} is $\sim 5{\cdot}10^5$ yr. B. ROSE

539.163

3722. On the radioactivity of potassium. M. Ceccarelli, G. Quareni and A. Rostagni. *Nuovo Cim.*, **8**, 132–43 (*Feb.*, 1951) *In Italian.*

539.163 : 539.154.2

3723. On the question of the existence of new α-emitters. B. Gysae. *Z. Naturforsch.*, **5a**, 530–3 (*Oct.*, 1950) *In German.*

Continuation of Abstr. 717 (1948). The preparation was purified by a series of precipitations with HF, alternately in the oxidized $[(NH_4)_2SO_5]$ and reduced $[H_2SO_3]$ states; Th and rare earths were removed by precipitation with oxalic acid in very weakly acid soln., the α-emitters precipitated with NH_4OH and the range curve of the α-particles measured [see Abstr. 8817 (1950)]. Any remaining U was removed by washing with $(NH_4)_2CO_3$ soln. and the α-range curve again taken. It shows α-particle ranges of 2·1, 2·5 and probably 3·0 cm, and these are attributed to elements for which $Z > 92$. The β-absorption curve (in Al) of the preparation was shown to differ from that of U. A. O. STANESBY

539.163 : 539.166

3724. The relation between γ-ray energy and half-period in *K*-capture. V. Beloselskiĭ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 6) 793–5 (1950) *In Russian.*

On plotting $\log \tau$ against $E\gamma$, most examples of *K*-capture lie on 1 of 4 straight lines of the form $\log \tau = a - bE\gamma$. Values of a and b for the four groups are given. E. P. GEORGE

539.163.1

3725. Half-life of Fe^{55} and Co^{60}. G. L. Brownell and C. J. Maletskos. Letter in *Phys. Rev.*, **80**, 1102–3 (*Dec.* 15, 1950).

Determinations of the ½-lives were made by following the activities of samples of Fe^{55} and Co^{60} using an argon-filled ionization chamber standardized against a Ra source. The ½-lives are: Fe^{55}, $2{\cdot}94 \pm 0{\cdot}029$ yr; Co^{60}, $5{\cdot}26 \pm 0{\cdot}17$ yr (standard error). A. O. STANESBY

539.163.1

3726. The half-life of K^{40}. F. G. Houtermans, O. Haxel and J. Heintze. *Z. Phys.*, **128** (*No.* 5) 657–67 (1950) *In German.*

The β-activity of thin layers of K salts placed inside a double β-counter was $n\beta = 27{\cdot}1 \pm 1{\cdot}5$ β-particles $(g\,K)^{-1}\ sec^{-1}$; the γ-activity was $n_\gamma = 3{\cdot}1 \pm 0{\cdot}3$ quanta $(g\,K)^{-1}\ sec^{-1}$, measured in a γ-counter calibrated with the γ-rays of Na^{24} and Co^{60}. Assuming the *K*-capture rate $n_K = n_\gamma$, the calculated ½-life of K^{40} is $T = (1{\cdot}33 \pm 0{\cdot}08) \times 10^9$ yr, and the rate of A production 3·1 atoms A^{40} $(g\,K)^{-1}\ sec^{-1}$ or $3{\cdot}6 \times 10^{-12}\ cm^3\ (g\,K)^{-1}\ yr^{-1}$. A. O. STANESBY

539.163.1

3727. The precision measurement of half lives of radioactive substances. L. M. Silver. *Canad. J. Phys.*, **29**, 59–65 (*Jan.*, 1951).

A vibrating reed electrometer with feedback amplifier has been used in conjunction with a differential ionization chamber to measure accurately the decay periods of several radioactive isotopes. This method proved to be simple, reliable and free from uncertain corrections, with a low background due to the differential technique adopted and a low drift rate (normally less than 5×10^{-17} A) due to the feedback electrometer circuit. This high and easily varied sensitivity enabled the decay to be followed over 12 periods, making possible the detection of, and correction for, any weak long-lived impurity activity, thus eliminating one major source of error in half-life measurements. Least squares analysis of the data showed that a quadratic mean error as small as ½% can be easily achieved with this apparatus. Half-life values were found as follows: Cu^{64} $12{\cdot}88 \pm 0{\cdot}03$ hr; Cu^{66} $4{\cdot}34 \pm 0{\cdot}03$ min; Ni^{65} $2{\cdot}564 \pm 0{\cdot}005$ hr; Au^{198} $2{\cdot}69 \pm 0{\cdot}01$ days; In^{116} $53{\cdot}93 \pm 0{\cdot}03$ min. A.

539.163.1 : 550.93

Radioactivity of potassium and age of the earth. *See Abstr.* 3961

539.163.2

3728. Emission of Au^{198}, Ho^{166} and Lu^{177}. N. M. Antoneva, A. A. Bashilov, B. S. Dzhelepov and A. V. Zolotavin. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 299–318 (1950) *In Russian.*

Improved focusing leads to the results: β-spectrum of Au^{198} is simple, with a γ-line suffering strong conversion; β-spectrum of Ho^{166} is complex, the lower γ-line shows strong conversion for *L*, *M* shells, weak for the *K* shell. A decay scheme for Ho^{166} is proposed. The β-spectrum of Lu^{177} is again complex, with 2 γ-lines. J. JACOBS

539.163.2

3729. Nuclear energy levels for some long-lived isotopes. J. M. Cork. *Nucleonics*, **7**, 24–33 (*Nov.*, 1950).

Results obtained by various authors, of measurements of beta- and gamma-ray energies from a number of radioactive isotopes, are summarized and energy level diagrams are drawn up to fit the observed data. The decay schemes included are those of Se^{75}, Ag^{110}, Cd^{115}, I^{131}, La^{140}, Pr^{142}, Eu^{152}, Eu^{154}, Tb^{160}, Yb^{169}, Yb^{175}, Yb^{177}, Hf^{181}, Ta^{182} and Pa^{233}. L. R. SHEPHERD

539.163.2

3730. The branching ratio of K^{40} radioactive decay. M. G. Inghram, H. Brown, C. Patterson and D. C. Hess. Letter in *Phys. Rev.*, **80**, 916–17 (*Dec.* 1, 1950).

The ratio of *K*-capture to β-emission for naturally occurring K^{40} was determined using the mass-spectrometric isotopic dilution method [Abstr. 582 (1951)] to obtain the A^{40} and Ca^{40} content of a KCl sample 10^8 yr old from the Stassfurt sylvine deposits: the values were $0{\cdot}360 \pm 0{\cdot}007$ p.p.m of A^{40} and $2{\cdot}84 \pm 0{\cdot}03$ p.p.m of Ca^{40} by weight, giving a ratio of *K*-capture/β-emission for K^{40} of $0{\cdot}1263$ ($\pm \sim 4\%$). This may be taken as a lower limit, since it assumes no loss of A^{40} or Ca^{40} during geological time. A. O. STANESBY

539.163.2

3731. Radioactivities of Ru^{105}, Rh^{105}, Br^{84}, and Br^{83}. R. B. DUFFIELD AND L. M. LANGER. *Phys. Rev.*, **81**, 203–7 (*Jan.* 15, 1951).

A lens spectrometer was used to study the disintegrations of Ru^{105} (4·5 hr), Rh^{105} (36·2 hr), Br^{84} (32 min) and Br^{83} (2·4 hr). Ru^{105} emits a simple beta-spectrum with an end-point energy of $1{\cdot}150 \pm 0{\cdot}006$ MeV. This is followed by a 0·726 MeV gamma-ray to a metastable level in Rh^{105}. The decay to the ground state of Rh^{105} proceeds with a gamma-ray of about 0·1 MeV, with a half-life of 45 sec. The ground state of Rh^{105} emits a simple beta-spectrum of $0{\cdot}570 \pm 0{\cdot}005$ MeV. No gamma-ray appears to be associated with this decay. Br^{84} emits a complex beta-spectrum which can be resolved into at least 4 groups with end points and relative intensities of 4·679 MeV (40%), 3·56 MeV (9%), 2·53 MeV (16%) and 1·72 MeV (35%). The 4·679 MeV group, which goes directly to the ground state of Kr^{84}, does not have a forbidden spectrum shape. It is suggested that the 32 min half-life may be associated with an isomeric level above the ground state of Br^{84}. The decay of Br^{83} consists of a single beta-ray group with a maximum energy of $0{\cdot}940 \pm 0{\cdot}010$ MeV. A.

539.164

3732. The energy of α-particles from Pu^{239}. M. CONJEAUD AND V. NAGGIAR. *C.R. Acad. Sci., Paris*, **232**, 498–9 (*Feb.* 5, 1951) *In French.*

This was found to be $5{\cdot}134 \pm 0{\cdot}015$ MeV (in agreement with previous experiments) by comparing the total ionization with that of the 5·298 MeV α-particles from Po and assuming a linear relation between ionization and energy [Abstr. 5901 (1950)].

W. J. SWIATECKI

539.165

3733. Natural β-ray spectrum of RaC. M. MIWA AND S. KAGEYAMA. *J. Phys. Soc. Japan*, **5**, 416–21 (*Nov.–Dec.*, 1950).

Using a 180° spectrometer and two G.M. counters in coincidence as detector, the spectrum has been re-examined with higher resolution than that used by Latyshev [Abstr. 2971 (1947)]. Many of the conversion lines found by Ellis and Aston with the photographic method [*Proc. Roy. Soc. A*, **129**, 180 (1930)] were resolved, and the relative intensities measured. Most but not all of the measurements of Ellis and Aston were confirmed. B. ROSE

539.165

3734. On the possibility of the emission of a particle having the charge of the electron, yet distinct from it, in β^+ and β^- radioactivity. G. CHARPAK AND F. SUZOR. *C.R. Acad. Sci., Paris*, **231**, 1471–3 (*Dec.* 18, 1950) *In French.*

Experiments on backscattering showed a difference between that of β-particles from Co^{60}, P^{32}, Na^{22} and conversion electrons from Tc^{99m}. The hypothesis in the title is advanced to account for this. B. ROSE

539.165

3735. On the absorption and back scattering of electrons and of β-radiation. G. CHARPAK AND F. SUZOR. *C.R. Acad. Sci., Paris*, **232**, 322–4 (*Jan.* 22, 1951) *In French.*

Continuation of previous work [Abstr. 3734 (1951)]. More experimental results are presented which are in conflict with the above. B. ROSE

539.165

3736. Beta-spectrum of As^{77}. E. N. JENSEN, R. T. NICHOLS AND J. CLEMENT. Letter in *Phys. Rev.*, **81**, 143–4 (*Jan.* 1, 1951).

539.165

3737. Beta-activity of potassium. C. F. G. DELANEY. Letter in *Phys. Rev.*, **81**, 158 (*Jan.* 1, 1951).

539.165

3738. On the non-existence of isomerism in Br^{82}. A. BERTHELOT, L. PAPINEAU AND C. HERCZEG. *C.R. Acad. Sci., Paris*, **232**, 498–9 (*Feb.* 5, 1951) *In French.*

The possibility that the presence of a considerable number of low-energy electrons in the β-spectrum of Br^{82} (period 35 hr) is associated with an isomeric transition: Br^{82*} (35 hr) $\rightarrow Br^{82} \rightarrow Kr^{82} + \beta^-$ was tested by preparing samples of activated ethyl bromide and analysing water rinses taken at intervals over a period of 4 days. The recoil of those nucleons which had undergone an isomeric transition would detach them from the ethyl bromide molecules and they would be detected in the water through their β^- radioactivity. Apart from the possibility of the latter being of very short duration the result showed that not more than 1·5% of the activity of period 35 hr could have taken place through an isomeric transition.

W. J. SWIATECKI

539.165

3739. Positron electron branching. W. MIMS AND H. HALBAN. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 311–12 (*March*, 1951).

The $\beta^+ : \beta^-$ branching ratio of Br^{80} was determined to be 1 : 27 by observing the gamma-gamma coincidences due to annihilation. Eight other nuclides were examined with negative results (Sc^{46}, As^{76}, Br^{82}, Rb^{86}, Ag^{110}, Cs^{134}, Ir^{192}, Au^{198}).

539.165.8 : 537.591.15

3740. On pair production by fast electrons. J. E. HOOPER, D. T. KING AND A. H. MORRISH. *Phil. Mag.*, **42**, 304–9 (*March*, 1951).

A study has been made of electron pairs directly produced by fast electrons in photographic emulsions. Evidence is presented to show that this process is of importance in the development of electromagnetic cascades present in the "soft" component of the cosmic radiation. It is found that the variation with energy of the cross-section for the interaction agrees with that predicted by theory. A.

539.166

3741. γ-Rays from the decay of N^{16}. C. H. MILLAR, G. A. BARTHOLOMEW AND B. B. KINSEY. Letter in *Phys. Rev.*, **81**, 150 (*Jan.* 1, 1951).

539.166

3742. On the internal-conversion radiation of plutonium 239. G. ALBOUY AND J. TEILLAC. *C.R. Acad. Sci., Paris*, **232**, 326–8 (*Jan.* 22, 1951) *In French.*

Internal conversion electrons have been observed in electron sensitive plates. 5 200 α-tracks were observed, of which 824 have an origin in common with that of an electron. The electron range distribution

corresponds to an energy of 30–35 keV, or the *L*-conversion of a 50 keV γ-ray. There are indications of an electron group corresponding to the *K*-conversion of a 200 keV γ-ray. B. ROSE

539.166

3743. The angular correlation of annihilation radiation. P. E. ARGYLE AND J. B. WARREN. *Canad. J. Phys.*, **29**, 32–5 (*Jan.*, 1951).

The angular distribution of annihilation radiation from Cu^{64} has been measured with a pair of scintillation counters in coincidence. Coincidences were found when the counters and source were not quite collinear. The relation between the non-collinear coincidence rate and angle of deviation λ could be closely approximated by $e^{-\lambda/\lambda_0}$, where $\lambda_0 = (3{\cdot}60 \pm 0{\cdot}04)\ 10^{-3}$ radian. Interpreting this departure from antiparallelism of the two photons as arising from the residual motion of the annihilating pair, the average momentum of their mass centre in Cu is found to be $(7{\cdot}20\ mc) \times 10^{-3}$ which corresponds to an electron energy of 13·2 eV, if the positron is assumed to be thermalized before annihilation. A.

539.166

3744. Crystalline diffraction spectrography of the electromagnetic radiation of RaD. M. FRILLEY, B. G. GOKHALE AND M. VALADARES. *C.R. Acad. Sci., Paris*, **232**, 50–2 (*Jan.* 3, 1951) *In French.*

The instrument was a curved-crystal type, using thin mica sheets, with electron-sensitive photographic plates for registration. The γ-lines at 46·7 and 32 keV were observed, also certain *L*-radiations (see also Abstr. following). B. ROSE

539.166

3745. *L*-spectrum emitted in the transmutation RaD → RaE. M. FRILLEY, B. G. GOKHALE AND M. VALADARES. *C.R. Acad. Sci., Paris*, **232**, 157–9 (*Jan.* 8, 1951) *In French.*

Continuation of earlier paper (preceding Abstr.). The intensities of the *L*-radiations are compared with those of Bi X-rays, and the results compared with calculated values. B. ROSE

539.166

3746. Scattering and absorption of gamma-rays. M. S. PLESSET AND S. T. COHEN. *J. Appl. Phys.*, **22**, 350–7 (*March*, 1951).

A formulation is presented of the scattering and absorption of gamma-rays in different materials. The range of gamma-ray energies considered is from 1 to 10 mc^2. Results are given for the transmission of gamma-rays through air and Pb. A.

539.166 : 530.145

3747. 2^{L-1}-magnetic 2^L-electric interference terms in γ–γ-angular correlations. S. P. LLOYD. Letter in *Phys. Rev.*, **81**, 161–2 (*Jan.* 1, 1951).

The ratio of the reduced matrix elements for emission of 2^{L-1} magnetic and of 2^L-electric radiation between states j, j' is shown to be real, thus restricting the number of parameters available to fit γ–γ-angular correlation data. R. H. DALITZ

539.166 : 537.12/.13

3748. Experimental evidence for the three-photon annihilation of an electron-positron pair. J. A. RICH. Letter in *Phys. Rev.*, **81**, 140–1 (*Jan.* 1, 1951).

The ratio of the cross-sections for 2- and 3-quanta annihilation was measured with a symmetrical coincidence set of 3 scintillation counters. The result is of the same order as the theoretical one (200 : 1), but is not accurate because the efficiency of the counters cannot be measured or estimated unambiguously. J. R. MADDOX

539.166 : 537.132

3749. Angular distribution and polarization of annihilation γ-emission. N. A. VLASOV. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 337–56 (1950) *In Russian.*

Under 2-quanta annihilation of positrons and electrons the angular distribution shows a mean value very close to 180°. Thus the mean positron energy is below 10 eV. The emitted annihilation quanta spread mainly in $\perp^r$ planes, i.e. they are perpendicularly polarized. J. JACOBS

539.166 : 537.531

3750. The *L* X-ray spectra from radioactive decay of transuranium elements. G. W. BARTON, JR., H. P. ROBINSON AND I. PERLMAN. *Phys. Rev.*, **81**, 208–13 (*Jan.* 15, 1951).

A bent crystal X-ray spectrometer is described, and some results are given on the analysis of *L*-series X-rays produced in radioactive decay processes of transuranium elements. There is generally good agreement between measured energy values of *L*-series lines and those predicted by the Moseley relationship. The relative intensities of the various lines produced in this case from γ-ray internal conversion, are compared with those emitted from U excited by electron bombardment and values reported of internal conversion excited X-rays in the region of Pb. A.

539.166 : 537.542

3751. Comparison of Geiger-counter and ion-chamber methods of measuring gamma radiation. W. K. SINCLAIR. *Nucleonics*, **7**, 21–6 (*Dec.*, 1950).

The relationship between the response of an air-wall ionization chamber and the counting rate in a Cu G.M. counter for γ-quanta of different energies is derived and the ratio between counting rate *C* and chamber current *J* is tabulated for quantum energies in the range 0·1–3·0 MeV. Experimental results of measurements of this ratio using 16 radio-isotopes giving mean gamma-ray energies ranging from 80 keV (Hg^{197}) to 2·07 MeV (Na^{24}) are quoted. A cylindrical graphite chamber of 5 mm wall thickness was employed in these measurements. The experimental results agree well with theory. Below 400 keV the ratio *C*/*J* rises sharply with decreasing γ-ray energy, but from 0·4–3·0 MeV it is fairly constant, increasing only slightly with energy, so that Cu counters are useful in this region for dosage measurements.

L. R. SHEPHERD

539.166 : 539.172.4

3752. γ-rays produced by slow neutron capture in beryllium, carbon, and nitrogen. B. B. KINSEY, G. A. BARTHOLOMEW AND W. H. WALKER. *Canad. J. Phys.*, **29**, 1–13 (*Jan.*, 1951).

The γ-rays were investigated with a pair spectrometer. Only one γ-ray was observed to follow capture in Be and in C; nine were observed from N. The neutron binding energies computed

from the energies of these radiations are: Be^{10}, 6·797 ± 0·008; C^{13}, 4·948 ± 0·008; N^{15}, 10·823 ± 0·012 MeV. The N γ-rays can be fitted into a term scheme containing the previously known excited states of N^{15}, obtained from the study of (d, p) reactions, together with one excited state at 9·16 MeV, hitherto unreported. A comparison of the intensities of the N and Be radiations shows that the radiative capture cross-section of N is at most 160 millibarns. A.

539.166.2

3753. Directional correlation between successive internal-conversion electrons. II. J. W. GARDNER. *Proc. Phys. Soc., Lond. A*, **64**, 238–49 (*March*, 1951).

A previous paper [Abstr. 1973 (1950)] examined the directional correlation $I(\theta)$ between two conversion electrons in cascade, each electron being ejected, with energy $\ll mc^2$, from an initial s-state, under the action of a pure electric multipole γ-transition, and $I(\theta)$ was shown to be completely determined by symmetry arguments alone in this case. In the present paper the same problem is considered for pure magnetic, and for mixed transitions. Here $I(\theta)$ usually appears as a weighted mixture of constituents $I_1(\theta)$, $I_2(\theta)$, etc., each of which is completely determined by symmetry arguments alone. The weight factors, however, must be determined from standard internal-conversion theory. A.

539.166.75

3754. A method of measuring gamma-ray absorption coefficients at 0·51 Mev. P. E. ARGYLE, G. M. GRIFFITHS AND J. B. WARREN. *Canad. J. Phys.*, **29**, 83–5 (*Jan.*, 1951).

The coincidence method described makes use of the angular correlation between pairs of annihilation quanta to eliminate the effect of scattered radiation usually present in absorption measurements. Mass absorption coefficients in $(g/cm^2)^{-1}$ found by this method are as follows: Pb, 0·1519 ± 0·0008; Cu, 0·0819 ± 0·0005; Al, 0·0831 ± 0·0013. A.

539.167.3 : 669

3755. Radioactive isotopes in industry. I. Metallurgy. *Atomics, Lond.*, **2**, 39–42 (*Feb.*, 1951).

Fe^{55} and Fe^{59} have been used in diffusion studies, particularly of steel and to investigate the corrosion of Fe. W^{185} has been used to determine the location of W in an alloy. Radioactive tracers have also been used for estimation of soil removal from metal surfaces, and various friction studies. METROPOLITAN-VICKERS

NUCLEAR REACTIONS 539.17

539.17 : 541.14

3756. The Szilard–Chalmers effect with slow and fast neutrons. W. RIEDER. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 290–303 (1950) *In German.*

The yield in the Szilard–Chalmers effect is studied in the case of the permanganate ion as a function of neutron energy, concentration and pH. J. THEWLIS

539.17 : 541.14

3757. Enrichment of antimony activity through the Szilard–Chalmers separation. M. KAHN. *J. Amer. Chem. Soc.*, **73**, 479–80 (*Jan.*, 1951).

539.17 : 541.14

3758. Separation of radiochlorine by the Szilard–Chalmers effect. J. K. MAJOR AND P. SÜE. *C.R. Acad. Sci., Paris*, **232**, 52–4 (*Jan.* 3, 1951) *In French.*

For C_2Cl_6, solid and in solution, and for CCl_4, the efficiency of separation: (*a*) is greater in the liquid than in the solid state; (*b*) is not dependent on the concentration of the solution; (*c*) diminishes with the irradiation time, exponentially in the case of the liquids, but only slightly in the solid case.

R. H. DAVIES

539.17 : 778.3

3759. A semi-automatic device for analyzing events in nuclear emulsions. M. BLAU, R. RUDIN AND S. LINDENBAUM. *Rev. Sci. Instrum.*, **21**, 978–85 (*Dec.*, 1950).

An apparatus is described the basic element of which is a microscope with a motor-driven stage. The operator controls the direction and speed of motion by a steering wheel and an accelerator pedal and drives the track to be analysed through a target. Range, grain density and geometrical orientation of tracks, etc., are automatically recorded on charts. Methods of measurements and results are discussed. A.

539.17 : 778.33 : 537.534.74

Measurement of scattering in the photographic plate. *See Abstr.* 3580

539.172

3760. Present state of nuclear physics. U. LIDDEL. *Nucleonics*, **7**, 15–20 (*Dec.*, 1950).

A summary of papers presented at the international conference organized by A.E.R.E., Harwell, and held at Oxford on Sept. 7th–13th, 1950.

L. R. SHEPHERD

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 3617–21.

539.172.11

3761. Emission of neutrons and protons from Ne^{22} by the bombardment of α-particles. Z. M. I. OLLANO AND R. R. ROY. *Nuovo Cim.*, **8**, 77–81 (*Feb.*, 1951).

The reactions $Ne^{22}(\alpha, n)Mg^{25}$ and $Ne^{22}(\alpha, p)Na^{25}$ were investigated by photographic technique. Two groups of neutrons were observed corresponding to Q-values $-0·916 \pm 0·07$ MeV and $-1·71 \pm 0·08$ MeV for $E_\alpha = 4·4$ MeV. A study of the reaction $Ne^{22}(\alpha, p)Na^{25}$ was made by the detection of β-particles due to $Na^{25}(\beta^-)Mg^{25}$, the incident energy of the α-particles being 4·8 MeV. A.

539.172.13

3762. Californium isotopes from bombardment of uranium with carbon ions. A. GHIORSO, S. G. THOMPSON, K. STREET, JR. AND G. T. SEABORG. Letter in *Phys. Rev.*, **81**, 154 (*Jan.* 1, 1951).

539.172.13

3763. Excitation functions of the reaction (p, n). I. J.-P. BLASER, F. BOEHM, P. MARMIER AND D. C. PEASLEE. *Helv. Phys. Acta*, **24** (*No.* 1) 3–38 (1951) *In French.*

Excitation function and absolute cross-section for (p, n) reactions have been investigated for the following initial nuclei: Cu^{63}, Cu^{65}, Zn^{66}, Zn^{67}, Zn^{68}, Ag^{107}, Ag^{109}, Cd^{110}, Cd^{111}, Cd^{112}, Cd^{114}, Sn^{117}, Sn^{120}, Sn^{122}.

The excitation functions have been measured by means of the stacked foils method using protons of 6·5 MeV energy, and the cross-sections followed up to 10^{-29} cm². The case of Cu^{63} has been examined with high resolution in the region of the threshold. The energy scale in the $\sigma(E)$ diagrams was plotted using stopping power values determined in the course of experiments. The results have been compared with the statistical theory of the nucleus taking new theoretical values $\xi > 1$ for the sticking probability. Detailed discussion has been given in the case of Cu^{63} where the theory shows good agreement with the experimental curve down to the threshold. The values of r_0 are shown to agree well with that found by neutron-induced reactions. A.

539.172.13

3764. Precise determination of the $Li^7(p, \alpha)He^4$ and $Be^9(d, \alpha)Li^7$ Q-values. W. Whaling and C. W. Li. Letter in *Phys. Rev.*, **81**, 150–1 (*Jan.* 1, 1951).

A 16 in double focusing 180° magnetic spectrograph was used to measure the energy of the α-particles from Li. Electrostatically-analysed H^+ ions (1 008 keV) and HHH^+(336 keV) were used with thin and thick targets, with energy constant within 0·1%. A source of ThC′ α-particles could replace the target for calibration, and the magnetic field was continuously monitored. The angle of observation was 89·3 ± 0·2°. *Q*-values at the two energies agreed to within 3 keV, and the final value was 17·338 ± 0·011 MeV, after correction for surface contamination of the target. Similarly, the *Q*-value for $Be^9(d, \alpha)Li^7$ was 7·151 ± 0·010 MeV, and from these and other data the He^4 mass was found to be 4·003840 ± 0·000018, in agreement with mass measurements. T. G. Pickavance

539.172.13

3765. The reaction $^{23}Na(d, \alpha)^{21}Ne$. A. P. French and D. M. Thomson. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 203–4 (*Feb.*, 1951).

Four groups of α-particles were found, indicating levels in Ne^{21} with excitation energies of about 0·38, 1·75 and 2·76 MeV.

539.172.13

3766. A study of (d, p) nuclear reactions. Yu. A. Nemilov. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 319–36 (1950) *In Russian.*

Using a photographic plate and absorption wedge, the reactions were studied for deuterons up to 4 MeV. Energy levels in O^{17}, F^{20}, Na^{24}, Mg^{25}, Al^{28} and Si^{30} are given. Marked asymmetry in the proton angular distribution is reported. At low energies, the protons are nearly all emitted in the direction reverse to that of the motion of the deuterons. The results are discussed in terms of "partial" deuteron penetration of nuclei. E. P. George

539.172.13 : 539.185

3767. The angular distribution of the neutrons from the d-d reaction. A. R. W. Wilson, D. W. Keam and D. N. F. Dunbar. *Proc. Roy. Soc. Vict.*, **60**, 75–80 (*Nov.* 30, 1950).

The distribution has been investigated at 145 kV and 190 kV by assuming that it is of the form $B(1 + A\cos^2\theta)$ and determining the value of A. This was done by measuring the intensity of the neutrons with Ag cathode Geiger counters at 90° and 0° to the incident deuteron beam. At 145 kV, A was found to be 0·90 and at 190 kV, 1·03; the error in each value being less than 10%. These values lie on the smooth curve for the proton distribution predicted by theory. A.

539.172.3

3768. Investigation of the photodisintegration of C^{12} into 3 alpha-particles. V. L. Telegdi and W. Zünti. *Helv. Phys. Acta*, **23** (*No.* 6–7) 745–94 (1950) *In German.*

Continuation of Abstr. 4153 (1949). Nuclear emulsion plates were irradiated with monochromatic (17·6 MeV) γ-rays from the (Li, *p*) reaction, or with bremsstrahlung from an electron synchrotron of max. energy 24 MeV and the 3-pronged stars obtained were examined. The reaction (at these energies) is a (γ, α) reaction, the excited Be^{8*} nucleus later disintegrating into 2 α-particles: the excitation energy of the residual nucleus is usually 3 MeV, but there is evidence for an excitation energy of ~ 8 MeV in 19% of the disintegrations, and in a very few cases the Be^8 nucleus is left in the ground state. The cross-section curve is of resonance form, with a max. of $9·7 \times 10^{-29}$ cm² at a γ-ray energy of ~ 19 MeV. The angular distribution is isotropic, and the angular momentum of the 3 MeV excited level of Be^{8*} is probably $J = 2$. The process may be used as a γ-ray spectrometer, with a resolution comparable with that of a pair spectrometer. A. O. Stanesby

539.172.3

3769. Photodisintegration of the alpha-particle and the inverse processes. B. H. Flowers and F. Mandl. *Proc. Roy. Soc. A*, **206**, 131–44 (*March* 22, 1951).

The partial cross-sections for photodisintegration of the alpha-particle are calculated in the usual 1st-order perturbation theory approximation, utilizing the symmetry properties of the wave functions of the alpha-particle and of the various product nuclei. From these results the cross-sections for radiative capture of protons by H^3, neutrons by He^3, and deuterons by deuterons, can be deduced. It is found that (*a*) the yield of gamma-rays from the $H^3(p\gamma)He^4$ reaction should increase with bombarding energy up to several MeV; (*b*) the radiative capture cross-section of He^3 for thermal neutrons should be negligible; and (*c*) the radiative cross-section for the D + D reaction should be smaller than that for the T + P reaction at corresponding energies by a factor of about 10^{-3}. Conclusion (*a*) is discussed in the light of recent experiments at Los Alamos, which purport to establish the existence of an excited state of the alpha-particle. A.

539.172.3

3770. Detection of $^{14}N(\gamma, d\,3\alpha)$ and $^{14}N(\gamma, pn\,3\alpha)$ reactions in nuclear emulsions. F. K. Goward and J. J. Wilkins. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 312–13 (*March*, 1951).

539.172.3

3771. Thresholds of photo-neutron reactions. R. Sher, J. Halpern and W. E. Stephens. Letter in *Phys. Rev.*, **81**, 154–5 (*Jan.* 1, 1951).

539.172.3

3772. Production of mesons by photons on nuclei. M. LAX AND H. FESHBACH. *Phys. Rev.*, **81**, 189–96 (*Jan.* 15, 1951).

The total cross-section, energy spectrum, and angular distribution of mesons produced by photons incident on a target nucleus have been expressed in terms of the nucleon momentum distribution within the nucleus. The theory used here is valid for photon energies greater than approx. 1·2 times threshold, and for all but the lightest nuclei. These results have been applied to C employing Goldberger and Chew's momentum distribution for the protons in C. Excellent agreement is obtained for the meson energy spectrum at 90° and the decrease in efficiency of meson production compared to free protons as targets. The change in efficiency with photon energy, and the meson spectrum at various angles can be used to determine the internal nucleon momentum distribution. Positive mesons yield the proton distribution, negative mesons the neutron distribution. A.

539.172.3

3773. The angular distribution of the neutrons produced in the photo-disintegration of the deuteron by the 2·51-Mev gamma-rays of Ga^{72}. G. R. BISHOP, H. HALBAN, P. F. D. SHAW AND R. WILSON. *Phys. Rev.*, **81**, 219–22 (*Jan.* 15, 1951).

The angular distribution of the neutrons resulting from the photo-disintegration of the deuteron by the 2·51 MeV gamma-rays of Ga^{72} has been studied. The ratio of the magnetic to the electric cross-section has been determined to be $0{\cdot}61 \pm 0{\cdot}04$. A discussion is given of the present status of the problem. A.

539.172.3

3774. Fall and re-increase of the $^{12}C(\gamma, 3\,^4He)$ cross section. J. J. WILKINS AND F. K. GOWARD. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 201–2 (*Feb.*, 1951).

An extension of earlier work [Abstr. 6061 (1950)]. The cross-section curve shows a considerable and effectively vertical drop at $E_T \simeq 12$ MeV (E_T = total energy release) or $E_\gamma \simeq 19{\cdot}3$ MeV. The cross-section subsequently increases again.

539.172.3 : 539.152.1

3775. Photodisintegration of the deuteron at some intermediate energies and the neutron-proton effective triplet range. J. H. CARVER AND D. H. WILKINSON. Letter in *Nature, Lond.*, **167**, 154–5 (*Jan.* 27, 1951).

The cross-section for photodisintegration of the deuteron was determined for 6 γ-ray energies between 4·45 and 17·6 MeV, and the effective range for triplet n–p interaction calculated on the basis of a square potential well, and of the Yukawa potential: the latter is $(1{\cdot}76 \pm 0{\cdot}09) \times 10^{-13}$ cm for the ground state. The experimental accuracy does not yet permit discrimination between the two extreme forms of the potential well. A. O. STANESBY

539.172.4

3776. The disintegration of boron by slow neutrons. H. FRÄNZ AND H. WESTMEYER. *Z. Phys.*, **128** (*No.* 5) 617–28 (1950) *In German.*

The sum of the energies of the α-particle and the Li nucleus was measured in an ionization chamber filled with A, to which had been added a few % of BF_3 or $B(OCH_3)_3$. An energy calibration was made using Po α-particles, and a range-ionization curve for α-particles, in the energy range 0·5 to 3 MeV, obtained and compared with the range-energy curves of Holloway and Livingston, and Jesse and Sadauskis [Abstr. 5225 (1950)]. The reaction energy is $2{\cdot}35 \pm 0{\cdot}10$ MeV, when the Li nucleus is formed in an excited state, and $2{\cdot}85 \pm 0{\cdot}10$ MeV, in the ground state. The measured range of the α-particle, and the range obtained from the range-energy curves, are compared. J. HUGHES

539.172.4

3777. The slow neutron resonant scattering of gold. J. TITTMAN, C. SHEER, J. RAINWATER AND W. W. HAVENS, JR. Letter in *Phys. Rev.*, **80**, 903 (*Dec.* 1, 1950).

The 4·87 eV Au resonance is investigated, using the Columbia slow-neutron velocity spectrometer, with results in excellent agreement with theory. The level parameters are evaluated. J. THEWLIS

539.172.4

3778. On the dispersion formula. J. HUMBLET. *C.R. Acad. Sci., Paris*, **231**, 1436–7 (*Dec.* 18, 1950) *In French.*

Gives a development of Siegert's formula for the elastic scattering cross-sections of light nuclei for neutrons, which is valid not only in the neighbourhood of the virtual energy levels but for continuous changes in the kinetic energy of the neutron over a large range. J. THEWLIS

539.172.4

3779. An attempt to find evidence for the (n, α) reaction in iron caused by slow neutrons. H. FARAGGI. *C.R. Acad. Sci., Paris*, **231**, 1475–6 (*Dec.* 18, 1950) *In French.*

Photographic plates loaded with Fe were exposed in a pile to a total neutron flux of $\sim 10^{12}$ neutrons/cm^2. No α-particles which could be attributed to this reaction were observed, and an upper limit to the cross-section of the reaction is estimated to be 6×10^{-29} cm^2. J. HUGHES

539.172.4

3780. Total neutron cross sections of several nuclei at 14 MeV. A. H. LASDAY. Letter in *Phys. Rev.*, **81**, 139 (*Jan.* 1, 1951).

539.172.4

3781. $(n,2n)$ and (n,p) cross sections. B. L. COHEN. *Phys. Rev.*, **81**, 184–8 (*Jan.* 15, 1951).

Cross-sections of several $(n,2n)$ and (n,p) reactions were measured by bombarding samples with a known flux of neutrons and measuring the induced beta-activity, making elaborate corrections for self-absorption of the beta-rays. Using the known energy spectrum of the incident neutrons, calculations were made of the cross-sections to be expected from Weisskopf's statistical theory, and the agreement was satisfactory. The results indicate that level densities in odd-odd nuclei are greater than those in even-even nuclei by a factor of 3 ± 1. Applications of the method to shielding and the use of threshold detectors are discussed. A.

539.172.4 : 539.152.1

3782. Studies of nuclear energy levels with fast neutrons. H. H. BARSCHALL. *Amer. J. Phys.*, **18**, 535–46 (*Dec.*, 1950).

A review of the work recently carried out by the author and his colleagues. A short account is given of the theory of neutron resonances, and the experimental methods described. Results on 11 elements are discussed, and illustrated with graphs (22 refs).

539.172.4 : 539.166

γ-rays produced by slow neutron capture in beryllium, carbon, and nitrogen. *See Abstr.* 3752

539.172.4

3783. Nuclear reactor project at North Carolina State College. C. K. BECK. *Nucleonics*, **7**, 5–14 (*Dec.*, 1950).

Describes the reactor which is being constructed with the co-operation of the U.S.A.E.C. The proposed reactor is of the "water boiler" type, the core consisting of a 12 in stainless steel cylindrical chamber containing an aqueous solution of about 1 kg of uranyl sulphate (highly enriched in U^{235}). The core will be surrounded by a graphite reflector and a concrete shield pierced by 4 in dia. experimental channels. The reactor is designed for operation at a maximum power of 10 kW and the thermal neutron flux in the core is expected to exceed 10^{12} $n/cm^2/sec$. L. R. SHEPHERD

539.172.4

3784. Ranges of the two uranium fission fragments in photographic emulsion. L. VIGNERON. *C.R. Acad. Sci., Paris*, **231**, 1473–5 (*Dec.* 18, 1950) *In French.*

Microscopic grains of UO_2 in Ilford E_1 emulsion provided the sources of fission fragments. Grains of diameter $> 1{\cdot}5\,\mu$ were ignored so that errors arising out of difference in stopping power of UO_2 and emulsion could be neglected. The individual ranges of the two fragments were found to be $L_1 = 10{\cdot}4\,\mu$, $L_2 = 13{\cdot}4\,\mu$ and the total track length $L_1 + L_2 = 23{\cdot}8\,\mu$. A total of 100 fissions was observed, the standard deviation in the distributions of L_1 and L_2 was $1{\cdot}0\,\mu$ and of $L_1 + L_2$, $1{\cdot}4\,\mu$. L. R. SHEPHERD

539.172.4

3785. Nuclear data for low power research reactors. *Atomics, Lond.*, **2**, 15–16 (*Jan.*, 1951).

The following data released by atomic energy authorities are quoted: thermal neutron cross-sections for U; natural U fission cross-section, 0·7–5·0 MeV; neutrons per thermal neutron fisson; prompt neutron energy spectrum; fast fission effect; resonance absorption integral.

539.172.4

3786. Upper limit for the time between fission and the emission of neutrons. T. M. SNYDER AND R. W. WILLIAMS. *Phys. Rev.*, **81**, 171–5 (*Jan.* 15, 1951).

The Baker experiment to detect times of delay greater than $\sim 5\times10^{-9}$ sec for the emission of fission neutrons has been performed by observing the change in fission neutron counting rate when fission fragments are allowed to fly away from a neutron counter as compared to the counting rate when the fragments are kept in the vicinity of the counter. The fission neutrons were detected by observing proton recoils in a thick-paraffin-lined proportional counter. The percentage of neutrons delayed by a time of at least 8×10^{-9} sec was found to be $(3{\cdot}6 \pm 2{\cdot}8)\%$. A.

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

3787. On the meson effect in deuterium. M. MARKOV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 5) 655–8 (1950) *In Russian.*

Calculates the cross-section for the production of neutral scalar and pseudo-scalar mesons in deuterium for various assumptions concerning the widths of the potential wells, etc. E. P. GEORGE

539.18

3788. On the π-meson absorption and emission mechanisms in nuclei. P. CÜER. Letter in *Phys. Rev.*, **80**, 906–7 (*Dec.* 1, 1950).

A mechanism is suggested for the production of π-mesons in nuclear collisions, in which the incident nucleon interacts with a cluster of nucleons H^2, H^3 He^4, similar to the process previously proposed for absorption [Abstr. 2936 (1948)]. J. HUGHES

539.18

3789. On the influence of the particle structure in the Møller scattering of μ-mesons on protons. E. CORINALDESI. *Nuovo Cim.*, **8**, 62–9 (*Jan.*, 1951).

The Møller-scattering of μ-mesons on protons is studied on the assumption that these particles are endowed with a structure. In the first part the form-factors are introduced empirically, while in the second part they are deduced from a particular meson theory as an illustration. A.

539.18

3790. On the decay of the π^- meson. L. LEDERMAN, J. TINLOT AND E. T. BOOTH. Letter in *Phys. Rev.*, **81**, 281–2 (*Jan.* 15, 1951).

The mesons were produced by bombarding a C target with protons accelerated to 385 MeV. The decay in flight was identified from tracks showing a sudden deflection $> 5°$. Fifty cases were observed, the most probable deflection being 12°. Assuming $m_\pi = 276$, the resulting μ-meson mass is 210 ± 6. E. P. GEORGE

539.18

3791. Properties of mesons. H. P. NOYES. *Nature, Lond.*, **167**, 170–2 (*Feb.* 3, 1951).

Summarizes present results and tentative theories. From general arguments, neutral and charged π-mesons are classified as pseudoscalar. Heavier mesons are discussed. E. P. GEORGE

539.18 : 537.591.8

3792. On the absorption of a nucleon cascade. L. JÁNOSSY. *Proc. Roy. Irish Acad.*, **53A**, 181–8 (*Oct.*, 1950).

It is shown that the equations describing the rate of decrease of nucleons of given energy on passing through nuclear matter [Abstr. 4162 (1949)] are applicable in the case of the absorption of a nuclear cascade with only a slight generalization of the notation. W. J. SWIATECKI

539.18 : 537.591.8

3793. Evidence concerning the existence of the new unstable elementary neutral particle. V. D. HOPPER AND S. BISWAS. Letter in *Phys. Rev.*, **80**, 1099–1100 (*Dec.* 15, 1950).

A fork of two tracks about 500 μ from the centre

of a large star in 400 μ thick Ilford G5 emulsion exposed at 70 000′ is described. The plane of the fork does not contain the star centre; the prongs are identified as proton and meson, each of momentum about 300 MeV/c, and the mass of the uncharged primary is estimated to be $(2\,370 \pm 60)m_e$. The absence of evaporation particles and of nuclear recoil expected were the event of collision nature rather than free decay is discussed. J. G. WILSON

539.181 : 539.132

3794. The intermediate cosine coupling in molecular beams. W. A. NIERENBERG. Letter in *Phys. Rev.*, **80,** 1102 (*Dec.* 15, 1950).

The molecular beam line shape for the diatomic case is reported for large J and all values of the magnetic field. The line shape for $x_I = 1$, a measure of the coupling, is highly asymmetric. J. JACOBS

539.185

3795. On the determination of effective cross-sections for thermal neutrons. G. GUÉBEN. *Bull. Soc. Roy. Sci. Liège*, **19,** 456–68 (*Nov.*, 1950) *In French.*

The notion of the effective cross-section is discussed and its determination for thermal neutrons in the case of B is reported (using good geometry and 6 different neutron detectors). The correction to the effective absorbing power of a medium (entering in the experiment) due to the obliquity of the neutrons emerging from the paraffin block containing the source was particularly studied. [H. A. Bethe, *Rev. Mod. Phys.*, **9,** 132 (1937); D. Frisch, *K. Dansk. Vidensk. Selsk.*, **14,** 12 (1937); W. J. Horvath and E. O. Salant, *Phys. Rev.*, **59,** 154 (1941)]. W. J. SWIATECKI

539.185

3796. The scattering lengths of the deuteron. D. G. HURST AND N. Z. ALCOCK. *Canad. J. Phys.*, **29,** 36–58 (*Jan.*, 1951).

The angular variation of the scattering of neutrons of 0·0724 eV energy by deuterium gas has been measured. Comparison with theoretical calculations of this variation gives a ratio of scattering lengths: $a_{\frac{1}{2}}/a_{\frac{3}{2}} = 0{\cdot}12 \pm 0{\cdot}04$ or $3{\cdot}2 \pm 0{\cdot}3$. In combination with the known total scattering cross-section of the free deuteron of $3{\cdot}44 \pm 0{\cdot}06$ barns this gives for the scattering lengths the two sets of values: $a_{\frac{1}{2}} = 0{\cdot}07 \pm 0{\cdot}03$, $a_{\frac{3}{2}} = 0{\cdot}638 \pm 0{\cdot}006$; or: $a_{\frac{1}{2}} = 0{\cdot}826 \pm 0{\cdot}012$, $a_{\frac{3}{2}} = 0{\cdot}26 \pm 0{\cdot}02$. A.

539.185

3797. Upper and lower bounds for the asymptotic neutron density in Milne's problem for the sphere. W. SEIDEL AND R. E. MARSHAK. *Canad. J. Phys.*, **29,** 72–82 (*Jan.*, 1951).

Rigorous upper and lower bounds for the asymptotic neutron density in Milne's problem for the sphere are calculated by means of an extension of Hopf's method for the plane. A.

539.185

3798. Scattering of neutrons by deuterons. E. CLEMENTEL. *Nuovo Cim.*, **8,** 185–94 (*March*, 1951).

The scattering of thermal neutrons by deuterons has been treated by solving by a variational method the equation of motion for S waves. A trial function with 3 variational parameters and a Gaussian potential with a depth of 45 MeV and a range of 2×10^{-13} cm have been used. The value of the cross-section does not depend sensibly on the types of forces which have been considered (neutral, symmetrical and a combination of Heisenberg and Majorana forces), and the contribution both of the states of quartet and doublet are of the same order. The ratio between the experimental and the theoretical cross-section is about 2; a better agreement would be obtained by increasing the range of the potential. A formula for the calculation of the phases for the higher-order waves has also been given. A.

539.185 : 535.2

3799. The angular distribution of the radiation at the interface of two adjoining media. S. CHANDRASEKHAR. *Canad. J. Phys.*, **29,** 14–20 (*Jan.*, 1951).

The results contained in a recent paper [Abstr. 7517 (1950)] are derived by certain elementary methods based on certain simple invariances characterizing the problem. A.

STRUCTURE OF SOLIDS 539.2

539.216 : 539.32

3800. Studies on the mechanical properties of cellulose fibers in relation to the internal structure. F. ANDERSEN. *Trans Danish Acad. Tech. Sci., No.* 13, 75 *pp.* (1950).

539.217

3801. A metallographic study of diffusion interfaces. G. C. KUCZYNSKI AND B. H. ALEXANDER. *J. Appl. Phys.*, **22,** 344–9 (*March*, 1951).

By sintering wires to flat metallic blocks, diffusion interfaces were obtained between the following pairs of metals: Cu–Ni, Au–Ag, Cu–Ag, Cu–Fe, Fe–Ni, Cu–Zn, Ni–Zn and 70/30 brass-Cu. The interfaces were subsequently investigated metallographically. Grooves were observed in the lower melting-point component in the vicinity of the sintered interfaces. This is attributed to the faster diffusion rates in the lower melting-point metal. A.

539.217 : 541.183

3802. Mechanism of the action of a gas on a solid. J.-M. DUNOYER. *Vide*, **5,** 905–11 (*Nov.*, 1950) *In French.*

Consists of mathematical discussion, and experimental data on the system MoO_3/H_2 at slightly above atmospheric pressure. The MoO_3 was prepared by the thermal dissociation of $Mo_7O_{24}(NH_4)_6.4H_2O$ and was very porous. L. G. CARPENTER

539.26 : 539.374 : 548.73

3803. Diffuse scattering of X-rays by plastically deformed monocrystals of aluminium. E. V. KOLONTSOVA. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 2) 189–92 (1950) *In Russian.*

Gives the results of the study of pictures of diffuse scattering of monochromatic radiation by stationary (undeformed and deformed) monocrystals of Al. It has been found that (1) the form and intensity of diffuse maxima and the temperature dependence of scattering intensity are identical for all undeformed and slightly deformed (deformation up to 1–1·5%)

Al monocrystals; (2) when the deformation attains 4–5%, the picture of the diffuse scattering of technically pure Al undergoes a change and becomes similar to that obtained with layer-crystals; (3) absolutely pure Al monocrystals do not show any change of picture until the deformation attains 8–10%.

F. LACHMAN

539.27

3804. The practice of electron microscopy. D. G. DRUMMOND (Ed.). *London, The Royal Microscopical Society* (1950) 141 *pp.*, 22 *plates.*

A treatise giving full working details of the techniques used in the preparation of specimens for examination in the electron microscope. Chapter headings: General optical considerations; Basic techniques; Examination of small particles; Airborne particles; Thin film specimens and surface replicas; Micro-organisms and viruses; Biological tissues; Special techniques; Calibration of magnification and resolving power; Photographic considerations [Reviewed in *Nature, Lond.*, **165**, 1009 (*June* 24, 1950)].

539.27

3805. An experiment on the use of the electron-microscope for measuring particularly small imprints obtained in micro-hardness testing. M. M. KRUSHCHEV AND E. S. BERKOVICH. *Izv. Akad. Nauk, Otdel. Tekh. Nauk, SSSR, No.* 11, 1645–7 (*Nov.*, 1950).

539.27

3806. Diffraction of electrons by graphite. J. HOERNI. *Helv. Phys. Acta*, **23** (*No.* 6–7) 587–622 (1950) *In French.*

The dynamic theory of diffraction is applied to graphite. Single crystals are used and, in favourable cases, their thickness may be determined. Particular attention is paid to the mode of stacking of the graphite layers and to transitions from one mode to another, information about which is obtained from the interference fringes observed within Kikuchi bands with low indices. The method developed confirms the existence of the rhombohedral modification in single crystals to the extent of about 5%. J. THEWLIS

539.27 : 539.215.4

3807. Electron microscopic investigations in soil science. W. FLAIG AND H. BEUTELSPACHER. *Optik*, **7** (*No.* 4–6) 237–40 (1950) *In German.*

The sizes and shapes of particles of humic acid of natural and synthetic origin are examined in the electron microscope. A study is also made of the reactions between humic acid and the inorganic (clay) constituents in soil. J. THEWLIS

539.27 : 539.216.1

3808. Electron microscopic investigation of textile fibres. W. KLING AND H. MAHL. *Optik*, **7** (*No.* 4–6) 217–18 (1950) *In German.*

Demonstrates the orientation of the fibrils in textile fibres, mainly cotton, by a replica technique. Platinum shadowing is employed. J. THEWLIS

539.27 : 539.219.1

3809. Electron optical investigation of the structure of banded pearlite and of pearlitic structure in a Cr magnet steel. A. SCHRADER. *Optik*, **7** (*No.* 4–6) 219–36 (1950) *In German.*

The examination of pearlite by electron microscopy was undertaken, using an Al replica technique. It was found that in large-grained material only the edges of the lamellae are attacked by the etchant. In fine-grained material a much stronger attack occurs and the difference between ferrite and carbide is less marked. Good agreement was obtained between the general results of electron and light microscopy for a Cr magnet steel, but more details can be recognized by the former technique. A Siemens 80 kV electron microscope was used. J. THEWLIS

539.27 : 539.234

3810. Electron microscopic investigation of the structure of evaporated Zn and Cd layers. E. ZEHENDER. *Optik*, **7** (*No.* 4–6) 200–7 (1950) *In German.*

The effect of impurities on the deposition of Zn and Cd layers is investigated, a silica replica technique being used. Electron diffraction is also employed to determine the texture of the evaporated layers.

J. THEWLIS

539.27 : 545.8

3811. Electron microscopy. F. A. HAMM. *Analyt. Chem.*, **23**, 17–20 (*Jan.*, 1951).

Annual review of progress in design and applications (61 refs.).

539.27 : 548.0

3812. Electron microscopic investigations on calcite and its crystal habit. G. PFEFFERKORN. *Optik*, **7** (*No.* 4–6) 208–16 (1950) *In German.*

Describes a variety of appearances seen in the electron microscope. An Al replica technique is employed and various etchants are used. J. THEWLIS

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.313

3813. Integral equations for the deformation vector in the statics of an isotropic elastic body. I. S. ARZHANYKH. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 6) 783–6 (1950) *In Russian.*

Subject to the existence of boundary conditions expressible in terms of Green's functions, the deformation vector of an isotropic elastic body can be expressed explicitly in the form of an integral equation. This is done in two cases: (i) when the surface deformation is specified; (ii) when derivatives of the deformation are specified. An integro-differential equation defining the specific energy of deformation is also derived. A. SCHOFIELD

539.319

3814. The measurement of stress and strain in solids. *London, Institute of Physics* (1948) xi + 112 *pp.*, 8 *plates.*

A symposium of twelve papers presented to an Institute of Physics Conference (1946) dealing with resistance, photoelastic, X-ray and acoustic strain gauges.

539.319 : 535.55

3815. Quenching stresses in transparent isotropic media and the photoelastic method. R. C. O'ROURKE AND A. W. SAENZ. Note n *Quart. Appl. Math.*, **8**, 303–11 (*Oct.*, 1950).

A mathematical theory of residual stresses based on a simple model of the quenching process is developed and the applicability of the photoelastic method in studying quenching stresses justified. The problem of the photoelastic determination of quenching stresses in spheres and cylinders is resolved into a simple problem in integral equations.

H. G. JERRARD

539.32

3816. The variation of Young's modulus of a binary body-centred alloy caused by the formation of superlattice. Y. SHIBUYA. *Sci. Rep. Res. Inst. Tohoku Univ., Ser. A*, **1**, 161–8 (*Oct.*, 1949).

A theoretical treatment relating the temperature variation of Young's modulus, E, of monocrystalline and polycrystalline β-brass to the degree of order S. Using the Bragg–Williams approximation a general relation $2E(S)/E(1) = (1 - S^2)(\xi_{AA} + \xi_{BB})/2\xi_{BA} + (1 + S^2)$ is obtained in both cases, where $\xi_{AA} = \frac{1}{3}(d^2V_{AA}/dr^2)$ etc., with the further approximation that lateral contraction consequent on longitudinal elongation is negligible. With reasonable values of the ξ, agreement with experiment is attained. The anisotropy of E is also discussed. E. P. WOHLFARTH

539.32

3817. The elastic parameters of beta-brass. R. A. ARTMAN AND D. O. THOMPSON. Letter in *J. Appl. Phys.*, **22**, 358 (*March*, 1951).

539.32 : 539.67

3818. A new apparatus for the measurement of the elastic modulus and internal friction in solids. A. KEPES. *Trans Instrum. Meas. Conf., Stockholm* (1949) 136–8 (1950) *In French.*

A theoretical examination leads to a method in which the specimen is fixed rigidly at one end and a force applied to the free end. The deflection is measured in terms of amplitude and frequency. Methods of measurement are considered and examples given. E. H. W. BANNER

539.32 : 541.64

3819. Dynamic shear properties of rubberlike polymers. I. L. HOPKINS. *Trans Amer. Soc. Mech. Engrs*, **73**, 195–204 (*Feb.*, 1951).

A simple apparatus for determining the dynamic properties of elastomers in shear at audio frequencies is appraised. Typical values of shear modulus and viscosity for several elastomers are given, both at room conditions and at 150°F. The frequencies of test range from 100 to 5 250 c/s, the shear moduli from $0{\cdot}5\times10^6$ to 480×10^6 dynes/cm^2 and the viscosities from 20 to 75 000 poises. A.

539.32 : 548.73

3820. The elastic constants of zincblende, determined from thermal diffuse scattering of X-rays. E. PRINCE AND W. A. WOOSTER. Note in *Acta Cryst.*, **4**, 191 (*March*, 1951).

539.371

3821. The deformation of elastic wires under their own weight. R. CHALÉAT. *Ann. Franç. Chronom. (Sér.* 2) **4** (*No.* 4) 397–410 (1950) *In French.*

A generalization of previous work [Abstr. 9040 (1950)] to cases which are of practical importance in chronometry. The deformation under its own weight, of a wire in the form of a plane spiral or a helix placed with axis horizontal or vertical, is calculated. Experimental results support the theory.

J. G. OLDROYD

539.371

3822. Volume changes in the stretching of vulcanized natural rubber. G. GEE, J. STERN AND L. R. G. TRELOAR. *Trans Faraday Soc.*, **46**, 1101–6 (*Dec.*, 1950).

Measurements are presented of the volume changes accompanying small ($\gtrsim$ 100%) elongations of vulcanized natural rubber completely free from undissolved particles. The small expansions found agree with those calculated from the known compressibility of the rubber and the hydrostatic component of the stretching force. It is pointed out that this volume change mechanism applies generally to any isotropic body, and does not contribute significantly (in rubber) to the tensile stress. A.

539.374

3823. Some aspects of the properties of methyl methacrylate. F. ZANDMAN. *C.R. Acad. Sci., Paris*, **232**, 311–12 (*Jan.* 22, 1951) *In French.*

Traction experiments show delayed elasticity and viscous flow [presumably] at room temperatures.

R. O. DAVIES

539.374 : 539.219.1

3824. Influence of the amplitude and of the speed of plastic deformation on the segregation of hydrogen in iron and steels. P. BASTIEN AND P. AZOU. *C.R. Acad. Sci., Paris*, **232**, 69–71 (*Jan.* 3, 1951) *In French.*

It is shown that at high and very low speeds of rupture H has no effect upon the capacity for plastic deformation of these metals. The effect is a maximum when the time for rupture lies between 10 sec and 30 min; it is suggested that in such cases the slow occurrence of plastic deformation causes the segregation of molecular H in faults which prevents further plastic flow, causing brittleness. H. P. MYERS

539.374 : 541.182.025

3825. The mechanism of thixotropic and plastic flow. C. GOODEVE. *Proc. 1st Int. Congr. Rheol., Scheveningen* (*Pt II*) 5–11; (*Pt III*) 18–20 (1948).

It is assumed that thixotropic materials contain long molecules or long coherent chains of structural elements which are strained and broken during flow; they are at the same time currently reformed. Hysteresis in latter process leads to thixotropy in a narrower sense. Yield stress is the number of such chains per unit area of a layer whose thickness is the length of the chains multiplied by the mean force in chains which is half of breaking force. This relationship is derived by means of the momentum theorem of mechanics. APPLIED MECHANICS REVIEWS

539.374 : 548.0

3826. On relaxation theory. D. Kühlmann, G. Masing and J. Raffelsieper. *Z. Metallkde*, **40**, 241–6 (*July*, 1949) *In German.*

Using a combination of dislocation and chemical reaction-rate theories, recovery of a single crystal from slight plastic deformation is calculated as a function of time and of temperature. Results show fair agreement with experimental work on single crystals of aluminium at temperatures ranging from 100 to 400°C, and for times ranging from 1 to 6 000 min. APPLIED MECHANICS REVIEWS

539.4 : 538.221 : 621.317.7 : 669.018

3827. Recent developments in alloys for instrument manufacture. W. F. Randall. *Trans Instrum. Meas. Conf., Stockholm* (1949) 250–3 (1950).

A résumé covering brief descriptions of Ni–Fe magnetic alloys, magnetic shunt alloys, low-expansion alloys, glass-sealing alloys, bimetals, spring materials and resistance alloys. Performance is given in characteristic curves. E. H. W. BANNER (R)

539.4 : 539.62

3828. The friction and mechanical properties of powders bonded by synthetic resins. R. C. Parker and E. J. W. Whittaker. *Proc. Phys. Soc., Lond. B*, **64**, 126–34 (*Feb.*, 1950).

The coefficient of friction and mechanical properties have been determined for a series of non-metallic materials formed by bonding mineral powders with resins. The manner in which the coefficient of friction varies with particle size has been studied, and a tentative explanation has been advanced involving certain geometrical parameters. A correlation was observed between the coefficient of friction and the hardness of the mineral powders expressed on Moh's scale. Marked correlations were also obtained between compression strength, cross-breaking strength and the reciprocal of the particle size for most of the materials; consideration is given to the various mechanical and thermodynamical factors involved. A.

539.4.016.2

3829. Fundamental aspects of the cold working of metals. M. Cook and T. L. Richards. *J. Inst. Met.*, **78**, 463–82 (*Jan.*, 1951).

Reference is made to the nature of the metallic state and metallic cohesion in terms of the electron theory of metals, and a brief outline is given of the several mechanisms involved in plastic deformation. These include crystallographic slip, twinning and kinking, and a shear mechanism to which particular attention is drawn because of its importance in many metal-fabrication processes. The influence of plastic deformation on structure is described with special reference to the development of preferred orientation in view of its technological significance, while the effect of deformation on the fine structure as revealed primarily by X-ray diffraction studies is considered in terms of the dislocation theory. The relation of work-hardening and plasticity to the structural changes brought about by cold working is also discussed. A.

539.434

3830. The application of Boltzmann's superposition theory to materials exhibiting reversible β flow. C. Henderson. *Proc. Roy. Soc. A*, **206**, 72–86 (*March* 22, 1950).

Boltzmann's theory of superposition is applied to the flow and recovery of a material in the so-called anelastic region, in which deformations outside the elastic region are slowly recoverable on removing the stress, and experimental work to test the theory is described. It is shown that the Andrade creep equation applies not only to large deformations of a completely irreversible character, but in this region also. Formulae have been worked out which give the amount of creep recovery, and of stress relaxation at constant strain, after any duration of an applied constant stress, for a material which at larger stresses exhibits the Andrade β flow. On comparing the formulae with existing data and with the results of experiments described in the paper, for both metallic and non-metallic materials, it is found that theory and experiment are in substantial agreement. A.

539.501 : 532.5

3831. The rheological aspect of hydrodynamics. M. Reiner. *Quart. Appl. Math.*, **8**, 341–9 (*Jan.*, 1951).

Tensor analysis of the most general relation between stress and rate of deformation leads to five coefficients of viscosity of which three are the ordinary (shear) viscosity μ, the coefficient of volume-viscosity μ_v and the coefficient of dilatancy δ, while one coefficient may be connected with the "Weissenberg-effect." The Stokes–Navier equations of hydrodynamics in which μ_v is neglected, can be used consistently only when the volume of the flowing liquid is constant. A.

539.531

3832. A micro-indentation hardness tester for attachment to the Vickers projection microscope. S. J. Lloyd and D. J. Norris. *J. Sci. Instrum.*, **28**, 81–4 (*March*, 1951).

An instrument has been designed and constructed, as an attachment for the Vickers projection microscope, to carry out hardness tests with impression size of 5–10 μ. This necessitated, for very soft materials, a load range below 1 g. Extensive tests of the instrument have shown it to be accurate within the desired range of load and impression size. A.

539.61 : 539.23

3833. The adherence of monomolecular layers to their support. H. Devaux. *C.R. Acad. Sci., Paris*, **232**, 368–70 (*Jan.* 29, 1951) *In French.*

Volatility of gases and solubility even of organic substances are lost completely in the monolayer. This adherence exists for the one side of molecules which is wetted and is due to attraction of the nearest atoms individually. Condensation on H_2O or Hg is not accompanied by chemical association. Wettability is an interface adherence phenomenon which a monolayer of oil, even if discontinuous, may alter completely. Rubbing of glass on glass, carrying a discontinuous monolayer of oil, becomes simple sliding; to overcome this adherence requires a pressure of 10 000 atm. J. JACOBS

539.621

3834. The lubrication of cotton and other textiles. E. Moss. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 19–23 (1951).

The frictional properties of cotton are controlled by the layer of natural wax on the fibres. Those finishing processes which remove wax tend to increase friction between cotton and other surfaces. The introduction of other surface layers, as in dyeing, may also increase friction. The high friction of wax-free cotton is reduced by the addition of lubricants, whose effect within some classes of compound varies regularly with chemical constitution. The lubrication, of regenerated celluloses is broadly similar. Low and uniform friction between textile and machine is very important in processes such as knitting and stitching. A.

539.621

3835. An introduction to boundary and extreme pressure lubrication. D. Clayton. *Brit. J. Appl. Physics, Suppl. No.* 1 [*Physics of Lubrication*] 25–33 (1951).

Relates boundary and fluid-film lubrication and refers to the explanations of boundary friction, in particular to the adhesion theory. Dealing with the influence of the main variables on friction values, velocity is first considered, together with the explanation of friction-induced vibrations in terms of the main type of friction/velocity curve; a simple general statement on the effects of temperature and surface roughness on friction cannot yet be given. Brief references are made to the high temperatures reached superficially at sliding contacts, and to electrical effects. In terms of these fundamental conceptions, a sketch is given of the mechanism of running-in, of wear (including wear testing and anti-wear additives), of the behaviour of surfaces under severe conditions leading to scuffing (including the function of extreme pressure lubricants). The value of solid lubricants and of chemical pre-treatment of the surfaces are mentioned. A.

539.621

3836. The boundary layer. G. I. Finch. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 34–5 (1951).

Reviews the present state of knowledge of the liquid and solid lubricant boundary layer. The function of the boundary layer is to replace the oxide-layer component of friction by one of still lower value. The structure of the oil boundary layer is discussed, and the effects of heat and sliding on this structure, particularly on the orientation of the lubricant molecules. Solid lubricants of the layer lattice type depend for their functioning on a large ratio of surface area to particle mass, and having on their surfaces firmly adhering liquid or gaseous adsorbed layers. A.

539.621

3837. Scuffing temperatures of boundary lubricant films. T. B. Lane. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 35–8 (1951).

The postulate of Blok that lubrication will fail when the temperature in the contact area reaches a value characteristic of the lubricant and sliding system is confirmed by experiments on the two-ball machine. It is shown that for the range of mineral oils tested the failure temperature increases with viscosity. A.

539.621

3838. Lubrication with materials in the solid state. F. T. Barwell and A. A. Milne. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 39–43 (1951).

Coefficients of friction between flat mild-steel surfaces loaded at an average intensity of 40 lb/in^2 at relative velocities of 0·01 cm/sec and 0·4 cm/sec were determined using talc, vermiculite, flake graphite, paraffin wax and various metallic soaps as lubricants. Only graphite, the metallic soaps and paraffin wax were shown to be effective lubricants and paraffin wax was selected for further study under conditions more in conformity with engineering practice. Results are given of tests in which mild steel treated by Sn plating, Cr plating and phosphating was continuously reciprocated against mild steel both unlubricated and lubricated with paraffin wax. A phosphated surface, lubricated with paraffin wax, formed the most satisfactory combination and it is suggested that, under the conditions embraced by the experiments, the porous nature of the surface coupled with the rheological properties of the paraffin wax might be the determining factors in performance. A.

539.621

3839. The lubrication of rough steel surfaces by a series of metallic soaps. F. T. Barwell and A. A. Milne. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 44–8 (1951).

Metallic soaps, a fatty acid, an ester, and a straight-chain hydrocarbon, all of approximately equal chain length, were used. The conditions of test covered a range of velocities and temperatures, but were confined to one set of surface conditions. Comparing interpolated values of friction for the different conditions, the melting-point of the solid lubricants was shown to be very critical, higher temperatures resulting in a sudden marked increase in friction. For greasy soaps, there was a continuous rise in friction over the range 25°C to 150°C. Differences in metallic ion or acid radical in the soaps had comparatively little effect on the friction other than that attributable to the physical state of the lubricant. There was evidence of progressive reaction with the metal surface in the case of the acid. The ester was a less effective lubricant than the soaps, while the hydrocarbon was a very poor lubricant. Microscopic examination of the surface damage showed that the solid lubricants were very effective in separating the surfaces, contact occurring only at intermittent points. With the melted lubricants considerably greater contact took place. A.

539.621

3840. The lubrication of metals by long chain organic compounds. K. V. Shooter. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 49–51 (1951).

The work of Bowden and his collaborators on the boundary lubrication of metals by fatty acids has shown that for efficient lubrication, chemical reaction and soap formation must occur. More work has suggested that more than an adsorbed monolayer

of soap on each of the sliding surfaces is required to produce a low coefficient of friction. An investigation has been made of the lubrication of several metals by a series of fatty acids. The friction results show that reaction and soap formation occur and that more than a monolayer of soap on each sliding surface is required for good lubrication. A.

539.621

3841. Physical changes in rubbing surfaces on scuffing. D. CLAYTON AND C. H. M. JENKINS. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 69–78 (1951).

Cast-iron surfaces rubbing against steel have been found to develop a thin layer of a "white constituent" when scuffing occurs or is approached. This material has not been fully identified, but the results point to it having a basis of two phases, viz. cementite and a quenched high-carbon ferritic phase developed from austenite, resulting from the high temperature developed by rubbing. In the laboratory work, using a 4-ball apparatus modified to take piston ring segments, this white material was also obtained in some degree with mineral oil under milder conditions than those causing scuffing, but not with the castor oil which proved better in preventing scuffing in running-in an aero-engine. A.

539.621

3842. The effect of lubrication on friction, wear and abrasion. P. GRODZINSKI. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 86–90 (1951).

The lubrication of a grinding surface is one of the most important items in abrasive processes, and experimental work on it is reported. Recent tests, in which the coefficient of friction was measured by an electronic dynamometer, employed a cast-iron disk in contact with a lubricated diamond surface. Using various oils, the coefficient of friction was generally below 0·08 without diamond powder and about 1·11 with the powder. A.

539.621 : 532.516

3843. Viscosity of lubricating oils at high rates of shear. A. F. H. WARD, S. M. NEALE AND N. F. BILTON. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 12–18 (1951).

Viscosity coefficients of lubricating oils have been measured, using a high-speed rotational viscometer, with a very thin oil-film. Special attention was given to the estimation of the temperature of the oil, so that the fall in viscosity caused by the rise in temperature might be allowed for. It was then found that at high rates of shear the coefficient of viscosity showed a decrease which was a function both of the rate of shear and of the temperature. This could be interpreted in terms of a balance between the orientation produced by the velocity-gradient and the disorientation caused by Brownian motion. A much more marked anomalous effect was shown when a viscosity-index improver was added to the oil. A.

539.621 : 537.221

3844. The electrostatic component of the force of friction. R. SCHNURMANN. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 62–8 (1951).

Experimental evidence has been presented previously in support of the view that jerky motion ("stick-slip" motion) of a frictional contact operated at a uniform rate of propulsion was of electrostatic origin. The electrification of frictional contacts is now considered and illustrated by discharge currents made visible on the screen of a cathode-ray oscilloscope. With a metallic friction element loaded against a rotating steel disk rapid oscillations are obtained at linear speeds of several hundred cm/sec. Their amplitude is independent of load and speed but can be increased by the addition of a dielectric material, and the oscillations can be made to disappear under conditions under which static charges cannot be held. Similar phenomena are obtained on substituting a rotating glass disk; then luminous spots are observed at temperatures below 400°C at the actual area of contact. A.

539.621 : 539.211

3845. An investigation of surface damage using radioactive metals. E. RABINOWICZ. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 82–5 (1951).

Experiments have been carried out in which a radioactive metal hemisphere slides over a non-radioactive metal surface, and the amount and nature of the transferred material are examined autoradiographically. It is found that metal transfer takes place in the form of discrete fragments, and that well-lubricated surfaces give less transfer than clean surfaces by factors of 400 or more. On heating well-lubricated surfaces, both the coefficient of friction and the amount of metal transfer increase markedly at the melting-point of the surface film. The metal transfer, however, in contrast to the friction, is sensitive also to temperature change below the surface film's melting-point, and this is explained as due to the softening of the surface film near its melting-point. In some cases, large non-radioactive fragments picked up on the radioactive slider prevent the transfer of radioactive fragments, and examples of this effect are shown. A.

539.621 : 539.27

3846. A study of boundary lubricant films by electron diffraction. J. W. MENTER. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 52–4 (1951).

Describes work on the orientation and structure of thin films of long-chain hydrocarbon compounds on metal surfaces. The effect of temperature has been investigated and results obtained correlated with frictional behaviour of sliding surfaces lubricated with the same compounds. It is concluded that good boundary lubrication occurs only when there is a closely packed solid film of oriented molecules on the surface. A.

539.621 : 539.378.2

3847. Surface welding and the extreme pressure lubricant. G. I. FINCH AND R. T. SPURR. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 79–82 (1951).

When two surfaces are brought into contact, the surface oxide films prevent intermetallic welding. The films may be ruptured by sliding the surfaces over each other, or by applying sufficient pressure to cause plastic flow at the interface. The ease with

which surfaces weld on sliding depends upon their rigidity and the nature and thickness of the surface films. Extreme-pressure additives react with the surface oxide to form a compound which is more fusible than the metal. If the local temperature should rise sufficiently during sliding, this compound will melt and smear over the surface, and act as a temporary lubricant. A.

539.621 : 539.501

3848. The rheology of lubricant films. E. W. J. MARDLES. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 7–12 (1951).

The rate of radial spread of a pool of liquid over polished horizontal surfaces or between optical flats, approaching or receding in a normal direction, has been measured for several lubricants and liquid mixtures. The quantitative results obtained have indicated divergences from normal hydrodynamic behaviour and are specific to the kind of lubricant and of the material of the surface. During the thinning of liquid films, rupturing with "pin holing" has been observed, the stage of onset varying with the kind of surface and lubricant. Evidence of the "wringing" together of flats has been obtained from sliding results at low pressure and by the separation of totally-immersed flats by normal pull with small forces. A.

539.621 : 539.575

3849. The spreading behaviour and lubricating properties of mixed liquids. E. B. BIELAK, E. W. J. MARDLES AND E. D. TINGLE. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 58–62 (1951).

Measurements of the rate of radial flow of several liquids and their binary mixtures over or between various polished surfaces have been correlated with friction results on the same surfaces. The results have been presented in graphical form relating composition of the binary mixture with the properties of friction and spreading. Divergences from the simple mixture law, sml $\mu \sim \mu$, where sml μ represents the friction calculated from the observed values of the single constituents of the binary mixture and μ the observed friction value are shown together with similar divergence values for spread, sml $d \sim d$, in terms of the size (diameter, radius or their logarithms) of a pool after a period of time. Changes in the molecular association of the liquids on admixture appear to account for the observed behaviours. A.

539.621 : 541.182

3850. The adsorption of lubricant films: a study of radioactive tracers. A. C. MOORE. *Brit. J. Appl. Phys., Suppl. No.* 1 [*Physics of Lubrication*] 54–7 (1951).

The chemical reaction between radioactive metal surfaces and adsorbed monolayers of stearic acid, ethyl stearate and octadecyl alcohol has been investigated. It is directly verified that when reaction occurs then the system exhibits good lubricating properties at temperatures above the bulk melting-point of the lubricant up to the softening point of the soap. If no reaction occurs lubrication is only found below the bulk melting-point of the lubricant. Reaction, when it does occur, does not cease with the formation of a monolayer of soap on the metal surface. If sufficient materials are present thick films of soap are built up. A.

539.67

3851. The viscosity and internal friction of solids. A. KAMMERER. *C.R. Acad. Sci., Paris,* **231,** 1285 (*Dec.* 6, 1950) *In French.*

If the elastic modulus decreases more rapidly with temperature than the viscosity, then it is shown that the damping of torsional oscillations increases with temperature. J. E. CAFFYN

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541.123.3

3852. Gas-liquid phase equilibrium in the system ammonia-hydrogen-nitrogen. A. MICHELS, G. F. SKELTON AND E. DUMOULIN. *Physica,* **16,** 831–8 (*Dec.*, 1950).

An instrument has been developed to measure the gas-liquid phase equilibrium in a mixture, which can, as a first approximation, be considered a binary system. The range covered in the experiments on N_2–H_2–NH_3 mixtures was limited to pressures of 10 to 800 atmos. and temperatures between 0 and 120° Celsius although these limits were not dictated by principal features of the instrument. The *P-t-x* relations for the two phases have been measured; the results are presented in diagrams giving the isotherms in the *P-x* projection, the isobars in the *t-x* projection and the lines of constant concentration in the *P-t* diagram. From the shape of the 115°c isotherm it is obvious that the phenomenon of retrograde condensation is realized in this system. A.

541.123.5 : 545.8

3853. Ion exchange. R. KUNIN. *Analyt. Chem.,* **23,** 45–6 (*Jan.*, 1951).

Annual review of analytical applications (86 refs.).

541.124

3854. Reactions in liquid sulphur dioxide. I. Exchange of oxygen between liquid sulphur and thionyl chloride. E. C. M. GRIGG AND I. LAUDER. *Trans Faraday Soc.,* **46,** 1039–41 (*Dec.*, 1950).

An investigation of the possibility of exchange of O between liquid SO_2 and $SOCl_2$, using the heavy isotope ^{18}O as a tracer element, has been carried out. No exchange was found to occur. This result indicates that some aspects of Jander's theory of reactions in liquid SO_2 are not correct. A.

541.127

3855. Energy and entropy changes of organic reactions. A. G. EVANS AND S. D. HAMANN. *Trans Faraday Soc.*, **47**, 25–49 (*Jan.*, 1951).

I. Two-stage reactions.—The rates of reaction of various alkyl chlorides (i) in 80% ethanol and (ii) in almost absolute formic acid, have been measured conductometrically. For the reactions in 80% ethanol, the $\Delta H^{\neq}$ and $\Delta S^{\neq}$ values have been obtained.

II. One-stage reactions.—The rates of reaction of some organic chlorides and bromides with KI in acetone solution have been measured conductometrically, and the $\Delta H^{\neq}$ and $\Delta S^{\neq}$ values obtained.

III. Ionization reactions.—E.M.F. measurements have been made to determine the values of ΔH° and ΔS° for the ionization of some amines. The results, together with those of other workers, are discussed in terms of the entropy of solvation of the amine ion. A relationship between the entropy of ionization of amines and the entropy of activation of reactions involving amines is pointed out.

IV. Theoretical considerations.—For the two-stage (S_{N_1}) reactions of RX, $\Delta S^{\neq}$ is shown to be related to the entropy of solvation of the ions R^+ and X^-. For one-stage (S_{N_2}) reactions of the type, $Y^- + RX \rightarrow YR + X^-$ the effect on $\Delta S^{\neq}$ of changing the groups R, X and Y is discussed. The effect of chain lengthening on $\Delta S^{\neq}$ for these reactions is related to the loss of internal rotational freedom of the hydrocarbon chain. A.

541.127

3856. The kinetics of the base-catalyzed decomposition of nitramide and deuterated nitramide in anisole. R. P. BELL AND E. F. CALDIN. *Trans Faraday Soc.*, **47**, 50–6 (*Jan.*, 1951).

The velocities of the decomposition of nitramide and of partly deuterated nitramide, catalyzed by dimethylaniline in anisole as solvent, have been measured, at five temperatures from 0° to 45°C. Contrary to what would be expected if quantum-mechanical leakage were important in controlling the rate of reaction, the results with ordinary nitramide obey the Arrhenius expression within experimental error, and comparison with the results with deuterated nitramide does not indicate a large increase of the temperature-independent factor on substituting D for H. A.

ELECTROCHEMISTRY 541.13

541.132 : 532.72

3857. The application of the Onsager theory of ionic mobilities of self-diffusion. L. J. GOSTING AND H. S. HARNED. *J. Amer. Chem. Soc.*, **73**, 159–61 (*Jan.*, 1951).

The Onsager equation [Abstr. 2056 (1946)] for the diffusion coefficient of an ion at very low concentration in a salt solution of relatively high concentration has been adapted to the phenomenon of self-diffusion. The limiting law of the theory has been derived and compared with experimental values of the self-diffusion of radioactive Na ion and radioactive I ion in NaI solutions, and of radioactive Ag ion in $AgNO_3$ solutions. The agreement between the theoretical predictions and experimental results is not exact but is reasonably satisfactory. A.

541.133

3858. The conductivities of potassium and lanthanum cobalticyanides and ferricyanides. J. C. JAMES AND C. B. MONK. *Trans Faraday Soc.*, **45**, 1041–50 (*Dec.*, 1950).

Conductivity measurements on aqueous solutions of $K_3Fe(CN)_6$, $K_3Co(CN)_6$ and $LaCo(CN)_6$ at 18° and 25°, and of $LaCl_3$ at 25° are reported. The limiting mobilities of the La^{+++}, $Fe(CN)_6^{\equiv\equiv\equiv}$ and $Co(CN)_6^{\equiv\equiv\equiv}$ ions have been carefully evaluated, and the differences between the experimental conductivities and the theoretical Onsager equation for the first three of these salts have been discussed quantitatively in terms of incomplete dissociation. $LaCo(CN)_6$ behaves as a weak electrolyte, and its conductivity curve shows abnormal behaviour at higher concentrations. This is explained by assuming that the extent of dissociation passes through a minimum. Thermodynamic data for this salt have also been calculated. A.

541.133

3859. A new conductivity meter for chemical fluids. H. BOUCKE. *Elektron*, **5**, 5–7 (*Jan.*, 1951) *In German.*

This instrument uses standard test tubes and external capacitive or inductive electrodes which are connected to a h.f. generator. The liquid column between the electrodes acts as an ohmic resistor in parallel to a capacitor. Frequencies range between 150 kc/s and 1 Mc/s. A sonde carrying two well-isolated metal electrodes can be used when internal electrode arrangements are desirable. The theoretical circuit uses a double triode and permits of continuous as well as individual measurements which can also be recorded. Absolute measurements should not be carried out. W. SUMMER

541.135

3860. Temperature coefficient of the amalgamated copper electrode at constant activity. M. BONNEMAY AND J. FAIRBANK. *C.R. Acad. Sci., Paris*, **232**, 409–11 (*Jan.* 29, 1951) *In French.*

The value of $\partial E/\partial T$ for the electrode Cu–Hg(1%) — Cu^{++} has been determined for solutions of cupric salts in the absence of foreign ions. The curves of $\partial E/\partial T = f(\log[Cu^{++}])$ are straight lines of slope 0·41 mV for the sulphate, and 0·53 mV for the nitrate. From $\gamma_m = \partial E/\partial T$ it is possible to calculate the variation of entropy $\Delta S = -T\gamma_m$ for the reversible transformation $Cu \rightleftharpoons Cu^{++} + 2e$; $\gamma_m = 0{\cdot}81$ mV per degree, $\Delta S = -37$ mV per degree, the activity of Cu^{++} being 1. A. J. MEE

541.135

3861. Simplified forms for free energy of the double layers of two plates in a symmetrical electrolyte. S. LEVINE AND A. SUDDABY. *Proc. Phys. Soc., Lond. A*, **64**, 287–302 (*March*, 1951).

Approximate formulae are obtained for the interaction (free) energy of the electric double layers of two parallel plates immersed in an electrolyte of the binary, symmetrical valency type. The three separate simplified expressions which are derived are good approximations at (i) large separations between the

plates, (ii) small separations between the plates, and (iii) moderate potentials. The first form is an extension of a result proposed by Verwey and Overbeek. The third form is a power series in the surface potential, the first term of which is identical with the expression obtained when the linear Debye–Hückel equation in the theory of electrolytes is used. These results are more suitable for numerical computations than the exact formula for the free energy, which is expressed in terms of elliptic integrals. A.

541.135.5

3862. Accurate potentials with the dropping mercury cathode. H. J. GARDNER. Letter in *Nature, Lond.*, **167**, 158–9 (*Jan.* 27, 1951).

It has been found that, under conditions of high concentration, resistance and mercury flow, the ohmic potential in a dropping Hg cathode is zero. Several half-wave potentials have been found to be slightly more positive than previous data have indicated.

F. LACHMAN

541.135.5 : 666 : 621.317.331

3863. Measurement of and effect of temperature on electrical resistance of glass electrodes. E. L. ECKFELDT AND G. A. PERLEY. *J. Electrochem. Soc.*, **98**, 37–47 (*Feb.*, 1951).

The apparent irregularities observed in measuring the electrical resistance of glass electrodes, as reported in the literature, are explained by the dielectric properties of glass. The use of d.c. is recommended, and the need for caution in the use of a.c. is indicated. An experimental technique is described which hastens the measurement with d.c. when dielectric absorption is bothersome. An experimental study is reported dealing with the effect of temperature on the resistance of glass electrodes, including ones of Corning 015 glass and others made from three newer *p*H-responsive glasses. The experimental results do not agree with previously employed equations. The Rasch and Hinrichsen relationship, $\log R = B/T + A$, where the resistance and T the absolute temperature is preferred. A nomograph is given for the glasses studied. The temperature-resistance behaviour of Corning 015 glass is mathematically the same for membranes immersed in solution and for the dry glass at elevated temperatures. A.

541.136

3864. Cells depolarized by air. Interpretation of static polarization. H. MOUREU, P. CHOVIN AND A. M. DE FICQUELMONT. *C.R. Acad. Sci., Paris*, **232**, 511–12 (*Feb.* 5, 1951) *In French.*

The curve of static polarization is discussed and possible explanations are considered. It is suggested that the most satisfactory is to suppose that the positive electrode acts as an electrolytic condenser. The surface of the C is surrounded initially by a thin film of gaseous O_2, but during the discharge the O_2 is progressively converted into OH^- ions. A. J. MEE

541.136.22

3865. A study of the behaviour of polarized electrodes. I. The silver/silver halide system. H. LAL, H. R. THIRSK AND W. F. K. WYNNE-JONES. *Trans Faraday Soc.*, **47**, 70–7 (*Jan.*, 1951).

Values for the standard potentials of the Ag/AgX electrodes (X = Cl, Br or I) are given over a temperature range of $-20°$ to $+60°$C. Overpotentials observed during the anodic formation of these electrodes have been recorded for a range of current densities and concentrations of halide solutions. For a wide range of conditions the results suggest that the overpotentials are due principally to an ohmic resistance of the deposited Ag salt proportional to the charge passed. The specific conductivities of the layers have been calculated and are given as a function of current density and the concentration of the solution in which the polarization was carried out. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.14

3866. The photochemistry of native proteins. E. K. RIDEAL AND R. ROBERTS. *Proc. Roy. Soc. A*, **205**, 391–408 (*Feb.* 22, 1951).

541.14 : 539.17

Szilard–Chalmers effect. *See Abstr.* 3756–8

541.141.1

3867. Rare constants in the high temperature photolysis of acetaldehyde. R. E. DODD. *Trans Faraday Soc.*, **47**, 56–62 (*Jan.*, 1951).

The photochemical decomposition of acetaldehyde has been studied in the temperature range 156–450°c using intermittent illumination at intensities of about 10^{-11} $Nh\nu$ cm^{-3} sec^{-1}. Rate constants for the chain propagation step k_2 and the bimolecular termination step k_3 are found to be

$$k_2 = 10^{12\cdot8\pm0\cdot4}\sqrt{(T)}\exp[(-10\cdot7\pm0\cdot5\ \text{kcal})/RT];$$
$$k_3 = 10^{13\cdot8\pm0\cdot6}\sqrt{(T}\exp[(-0\cdot8\pm0\cdot8\ \text{kcal})/RT],$$

mole^{-1} cm^3 sec^{-1}.

The mechanism of the photolysis is discussed. A.

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.18.041.3

3868. The application of the mass law to the aggregation of colloidal electrolytes.. M. J. VOLD. *J. Coll. Sci.*, **5**, 506–13 (*Dec.*, 1950).

It has been shown that experimental data for colloidal electrolytes which are in accord with the predictions of the mass law for a single micellar species are capable also of an entirely similar description in terms of the mass law for a distribution of micellar species. The results also suggest that in this distribution large micelles are favoured, and that as the concentration of colloidal electrolyte increases, the proportion of bound counter ion tends rapidly toward a constant value which is not very different for different colloidal electrolytes. A.

541.182 : 537.531 : 535.434

3869. Low angle X-ray diffraction of colloidal gold and carbon black. J. TURKEVICH AND H. H. HUBBELL. *J. Amer. Chem. Soc.*, **73**, 1–7 (*Jan.*, 1951).

An apparatus for the determination of low-angle X-ray scattering of particles of colloid size has been

described and applied to the determination of the particle size of monodisperse colloidal gold and of carbon black. The values of the particle size so obtained were found to agree satisfactorily with measurements using the electron microscope. The wavelength-dependence of the X-ray scattering was also determined and was found to agree with theoretical predictions. Experimental evidence is presented for the existence of a theoretically predicted maximum in the X-ray low angle scattering curve. A.

541.182.025

3870. The McKee worker-consistometer with constant speed drives. S. A. McKee and H. S. White. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 18–29 (*Jan.*, 1951).

Two constant-speed drives have been developed for use with the McKee worker-consistometer for mechanically working a fluid and measuring its flow characteristics in the same series of operations. Test data are given showing the effect of mechanical working upon the flow characteristics of some lubricating greases and some raw synthetic rubbers. The results show that the apparatus provides a tool useful in the measurement of the apparent viscosity and the effect of mechanical working for non-Newtonian materials having thixotropic properties. The performance of the apparatus is adequate to cover consistencies of materials ranging from a light lubricating grease to 100% of raw rubber. A.

541.183

3871. Sorption of water by dehydrated alum crystals. A. Bielanski and F. C. Tompkins. *Trans Faraday Soc.*, **46**, 1072–80 (*Dec.*, 1950).

The sorption of water vapour on single crystals of potash alum dehydrated for 18 hr at 55°c has been investigated in the temperature range 45–62°c at relative vapour pressures p/p_s between 0·04 to 0·95. First-layer adsorption on the easily accessible surface is reversible and complete at a relative pressure of 0·04. Second (and higher) layer adsorption proceeds at higher pressures and largely controls the rate of diffusion of water into the dehydrated alum. The heat of "desorption" is 11 kcal/mole water and the activation energy associated with the diffusion process is less than 500 cal/mole. The amount sorbed at time t is a linear function of $t^{\frac{1}{2}}$; there is, however, some evidence that the sorbent swells causing the diffusion coefficient to increase with increasing amount sorbed. At the composition $Al_2(SO_4)_3$ 9·4 H_2O a transformation occurs during hydration giving a "glassy" modification which is very stable to further hydration on dehydration. X-ray examination, however, indicates that this is not a new ordered phase. A.

541.183

3872. The adsorption of gases on caesium iodide. F. C. Tompkins and D. M. Young. *Trans Faraday Soc.*, **47**, 77–87 (*Jan.*, 1951).

The adsorption of CO, N_2, A and O_2 by CsI between 65·5 and 91·6°K has been measured and heats of adsorption have been calculated. The effect of surface heterogeneity, lateral interactions and second-layer formulation on the variation of the heat of adsorption with coverage and on the evaluation of monolayer capacity by the Brunauer–Emmett–Teller method is discussed. The equilibrium form of CsI is shown to be a rhombic dodecahedron and in consequence adsorption takes place on the (110) and not on the (100) surfaces as previously assumed by Orr in his theoretical calculations—the discordance of experimental and calculated heats is thereby explained. A.

541.183

3873. The adsorption of gas mixtures. F. C. Tompkins ans D. M. Young. *Trans Faraday Soc.*, **47**, 88–96 (*Jan.*, 1951).

The adsorption of two binary gas mixtures N_2 + CO at 83·6°K and A + O_2 at 77·5°K by CsI have been measured using a constant volume method. The usefulness and validity of the "mixed" Langmuir equation in representing the results have been assessed and a possible extension to non-uniform surface is indicated. A.

541.183

3874. Some comments on the B.E.T. (Brunauer–Emmett–Teller) adsorption equation. D. C. Jones. *J. Chem. Soc.* (1951) 126–30 (*Jan.*).

The B.E.T. adsorption equation is compared with Langmuir's Cases IV and VI. An analysis of the equation leads to corrected conditions for the occurrence of adsorption curves of types II and III. The locus of the points of inflection realizable in type II curves is investigated. A.

541.183 : 531.72

3875. Surface-area determination by adsorption of nitrogen from nitrogen-helium mixtures. W. V. Loebenstein and V. R. Deitz. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 51–5 (*Jan.*, 1951).

A new apparatus and technique, in which vacuum pumps and associated equipment are not required, have been developed for the determination of the adsorption of N from mixtures with He for use in the determination of surface area. The sample is heated initially in a stream of He. The adsorption of He is negligible at the temperatures concerned. The gas mixture is cycled repeatedly over the adsorbent until no further change in pressure is observed. Temperature equilibrium is attained rapidly. It is shown that thermomolecular pressure differences are negligible under the conditions of the experiment. Surface-area determinations by the simplified technique are in good agreement with results obtained by the conventional volumetric method when the same adsorbents are used with various residual He pressures. A.

541.183 : 539.234

3876. Adsorption on evaporated tungsten films. I. Oxygen and carbon monoxide chemisorption and the determination of film surface areas. E. K. Rideal and B. M. W. Trapnell. *Proc. Roy. Soc. A*, **205**, 409–21 (*Feb.* 22, 1951).

The two methods used give results which agree, and the film areas have been determined to an accuracy of about 5%. Chemisorption of O is followed by a second process, probably an oxidation, which slows very rapidly as gas is taken up, and for which an activation energy of 7 000 cal has been evaluated. The heat of CO chemisorption is so low in densely

packed layers that measurable equilibrium gas pressures are required even at liquid-air temperatures for completion of chemisorption. Values for the fraction of the surface atoms covered at various temperatures and pressures have been obtained, together with isothermal heats at various coverages. At the lowest temperatures onset of second-layer formation has been observed; first- and second-layer formations do not form a stepwise process. A.

541.183 : 539.234

3877. Adsorption on evaporated tungsten films. II. The chemisorption of hydrogen and the catalytic parahydrogen conversion. B. M. W. TRAPNELL. *Proc. Roy. Soc. A*, **206**, 39–50 (*March* 22, 1950).

The chemisorption of H in densely packed layers on W is reversible even at liquid-air temperatures. Values for the fraction of surface atoms covered, θ, are obtained for various temperatures and pressures and the combination of isothermal heats for high θ values with previously published calorimetric heats for low θ values gives the heat curve for the whole chemisorption from $\theta = 0$ to 1. The results are applied to the kinetics of the parahydrogen conversion, and it is claimed that reaction proceeds according to the equation $2W + H_2 \rightleftharpoons 2WH$. A.

541.183.54

3878. Application of a functional [time-base] sweep circuit for the oscillographic determination of heats of adsorption of ions and atoms of alkali metals. U. ARIFOV AND V. M. LOVTSOV. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 3) 365–6 (1950) *In Russian.*

The heat of vaporization of K ions from tungsten, calculated from the equations of Starodubtsev [Abstr. 5761 (1950)] by applying the method of Tolstoi and Feofilov [Abstr. 4447 (1949)] is $\lambda_+ = 2{\cdot}41$ eV.

F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.57

3879. Some physical properties associated with "aromatic" electrons. III. The pseudo-metallic properties of potassium-graphite and graphite-bromine. F. R. M. MCDONNELL, R. C. PINK AND A. R. UBBELOHDE. *J. Chem. Soc.* (1951) 191–7 (*Jan.*).

Pt II, Abstr. 4220 (1950). Graphite is known to form "lamellar compounds" C_8K and C_8Br by absorption of potassium and bromine, respectively. Physical properties of these compounds have been studied to elucidate the nature of the bonding, and its effects on the aromatic π electrons in graphite. The marked diamagnetism associated with the π electrons in graphite is destroyed in both compounds. C_8Br is weakly diamagnetic, and C_8K shows a temperature-independent paramagnetism of the same order as for metallic Ca. Both compounds are better conductors of electricity than is graphite. A tentative interpretation of these effects is given in the light of the band theory of the energy levels in graphite. The layers of fused aromatic nuclei are regarded as amphoteric, and can both take up electrons from the K atoms, and give them up to the Br atoms, yielding pseudo-metallic structures in both cases. Magnetic and electrical data on a compound of formula C_4F whose structure has not yet been established by other means suggest a general similarity in behaviour with graphite. A.

541.57

3880. Conjugation in sulphones. H. P. KOCH AND W. E. MOFFITT. *Trans Faraday Soc.*, **47**, 7–15 (*Jan.*, 1951).

The possibilities of conjugation in unsaturated or aromatic sulphones have been investigated on the basis of molecular orbital theory. It is found that different kinds and degrees of conjugation arise in differently substituted compounds, depending on the number (one or two) and steric arrangement of the unsaturated groups attached to the S atom. Strong conjugation is predicted for thiophene-1-dioxides and related structures, and rather weaker donor-acceptor type conjugation not affecting the oxy-sulphur bonds for diphenyl sulphones. These and other similar conclusions are in excellent agreement with and reconcile the hitherto seemingly rather contradictory chemical and spectroscopic evidence on sulphone conjugation. A.

541.57

3881. Length of central bond in thiophthen. V. SCHOMAKER. *Acta Cryst.*, **4**, 158–60 (*March*, 1951).

541.64 : 536.662

3882. Heat of polymerization of alpha-methylstyrene from heats of combustion of monomer and four polymer fractions. D. E. ROBERTS AND R. S. JESSUP. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 11–17 (*Jan.*, 1951).

Measurements have been made with a bomb calorimeter of the heats of combustion ($-\Delta Hc^\circ$) at 25°C to form gaseous CO_2 and liquid water, of liquid alpha-methylstyrene (1-methyl-1-phenylethylene) and four fractions of its solid polymer having number average molecular weights of (i) 5 400, (ii) 3 750, (iii) 2 200 and (iv) 1 300. The values of heat of polymerization obtained from these are: fraction I, 8·83; fraction II, 9·04; fraction III, 9·37; and fraction IV, 10·13 kcal/mole of monomer. The standard deviations of the mean for heat of combustion are not more than 0·30 kcal/mole, and for heat of polymerization, not more than 0·26 kcal/mole. The decrease in heat of polymerization with increasing molecular weight is discussed. The low values of heats of polymerization are ascribed in part to steric interference between the substituent groups of the polymer chain. A.

541.64 : 541.128

3883. The catalyzed polymerization of gaseous formaldehyde. J. C. BEVINGTON AND R. G. W. NORRISH. *Proc. Roy. Soc. A*, **205**, 516–29 (*March* 7, 1951).

CHEMICAL ANALYSIS 543/545

543

3884. Automatic operations in analytical chemistry. G. D. PATTERSON, JR. AND M. G. MELLON. *Analyt. Chem.*, **23**, 101–17 (*Jan.*, 1951).

Annual review of progress (483 refs.).

545.3

3885. Polarographic theory, instrumentation, and methodology. J. J. LINGANE. *Analyt. Chem.*, **23**, 86–99 (*Jan.*, 1951). Annual review (61 refs.).

545.37

3886. Potentiometric titrations. N. H. FURMAN. *Analyt. Chem.*, **23**, 21–4 (*Jan.*, 1951).

Annual reviews (91 refs.).

545.37

3887. Some non-electrical properties of the dropping mercury electrode. G. S. SMITH. *Trans Faraday Soc.*, **47**, 63–70 (*Jan.*, 1951).

The theory of the non-electrical properties of the dropping electrode has been re-examined, new relations between drop weight and other characteristics have been obtained, and experiments covering a wide range of pressures have been carried out. The true shapes of Hg drops from different capillaries with orifice radii ranging from 17 μ to 200 μ have been studied by means of ciné-photographs, and calculations have been made of volumes and surface areas at various stages of drop growth from measurements of the enlargements. A.

545.38 : 621.317.39

3888. Conductimetric analysis at radio-frequency. G. G. BLAKE. *London, Chapman and Hall* (1950) 109 *pp.*

The book describes the development of the author's work from his early research, in 1920, to 1950, and gives a résumé of the results obtained by other workers. The method consists in observing the change in anode current of an r.f. oscillator when a conducting body (e.g. an electrolyte) is loosely coupled to the tank circuit. Practical details and typical results are given for many applications, including the measurement of solution concentration and diffusion rate; analysis and titration; the compounding of standard solutions; the study of chemical kinetics, delayed chemical reactions and plant nutrition; liquid flow control. A chapter describing 9 selected moisture meters is included. A brief discussion, with references, is given of applications to the comparison of alcohols, plant nutrition, botany and agriculture, sugar refining, haematology, tanning, paper manufacture, electrotherapeutics, zoology, wines, drinking water, the control of chemical processes and protein chemistry. The emphasis throughout is on the adjustment and manipulation of the apparatus and the provision of practical information. C. F. BROCKELSBY (R)

545.7 : 536.23

3889. Thermal conductivity bridge for gas analysis. C. C. MINTER AND L. M. J. BURDY. *Analyt. Chem.*, **23**, 143–7 (*Jan.*, 1951).

The apparatus described will analyse a ternary mixture of, e.g., H_2 and CO_2 with air without the need to remove one component by absorption. Two conventional bridges are combined, the cells of one being of larger diameter which introduce a "convection" effect. The method can be used on any ternary mixture whose constituents differ sufficiently in thermal conductivity. A.

545.721 : 538.222

3890. Oxygen analysis based on its paramagnetic properties. R. S. MEDLOCK. *Trans Instrum. Meas. Conf., Stockholm* (1949) 102–6 (1950).

The "magnetic wind" is described, by means of which the O_2 may be measured by its paramagnetic property. An improved instrument has been devised and its performance mathematically determined. One recorder had an accuracy of $\pm 0{\cdot}05\%$ O_2 in a range of 0–5% O_2, with a 10 in scale.

E. H. W. BANNER

545.8 : 539.16

3891. Nucleonics. C. L. GORDON. *Analyt. Chem.*, **23**, 81–8 (*Jan.*, 1951).

Annual review of analytical applications of radioactivity (122 refs.).

545.82

3892. Report of a colloquium on spectroscopy—Strasbourg, 1950. E. VAN SOMEREN. *Brit. J. Appl. Phys.*, **2**, 55–6 (*Feb.*, 1951).

The report gives brief details of the more important papers presented. The subjects covered included: standard samples and electrodes; direct-reading analysis; calibration line drift; c.r. tube presentation of density profiles of lines, and alteration of line intensities of trace elements by the presence of added salts; use of low-pressure sources for estimation of non-metals, and of the Tesla spark for tracing distribution of an impurity between the phases of an alloy; and fundamentals of spark spectra and plate calibration. The organization of spectroscopists for exchange of information and for standardizing work was discussed; also proposals for international co-operation. S. T. HENDERSON

545.82

3893. Infrared spectroscopy. R. C. GORE. *Analyt. Chem.*, **23**, 7–12 (*Jan.*, 1951).

Annual review (354 refs.).

545.822

3894. Light absorption spectrometry. M. G. MELLON. *Analyt. Chem.*, **23**, 2–7 (*Jan.*, 1951).

Annual review (217 refs.).

545.823

3895. Ultraviolet absorption spectrophotometry. E. J. ROSENBAUM. *Analyt. Chem.*, **23**, 12–14 (*Jan.*, 1951). Annual review (43 refs.).

545.824

3896. X-ray absorption. H. A. LIEBHAFSKY. *Analyt. Chem.*, **23**, 14–16 (*Jan.*, 1951).

Annual review (29 refs.).

545.843

3897. Chromatographic systems. H. H. STRAIN. *Analyt. Chem.*, **23**, 25–38 (*Jan.*, 1951).

Annual review of progress (420 refs.).

545.843

3898. Use of beta-ray densitometry in paper chromatography. Note in *Analyt. Chem.*, **23**, 207–8 (*Jan.*, 1951).

By the use of radioactive tracers, zones of a paper chromatogram can be analysed by direct scanning with a slit and counter system coupled to a pen recorder.

CRYSTALLOGRAPHY 548

548.0 : 537.226

3899. Revised dielectric parameters of alkali and halide ions. S. ROBERTS. Letter in *Phys. Rev.*, **81**, 161 (*Jan.* 1, 1951).

In a previous publication [Abstr. 4470 (1950)] use was made of certain parameters to describe a model of a polarizable ion, these parameters being used, e.g., in expressions for dielectric and optical polarizability. Two of these parameters for Li had been arbitrarily put =0. Revised values for these have been derived which lead to new values for the other ions. These are tabulated. The basis of the derivation is critically considered. A. J. KENNEDY

548.0 : 539.89

3900. Rochelle salt preparation, high-pressure-moulded for crystal plates. F. BLAHA. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 272–7 (1950) *In German.*

Slices are cut from Rochelle salt crystals and moulded under pressure of 17 000 kg/cm² in the direction of the *a*-axis, to pastille shapes. With low pressure the pastilles turn out white and granular, but with sufficiently high pressure (12 000 kg/cm²) they are clear as glass with no signs of re-crystallization, according to X-ray photographs. These preparations are tested for conductivity and dielectric constant as a function of temperature and the results are graphically presented. A. M. THOMAS

548.127

3901. Vector presentation of 230 space groups. P. NIGGLI. Note in *Acta Cryst.*, **4**, 190 (*March*, 1951) *In German.*

548.19

3902. The Barker index of crystals. Note in *Acta Cryst.*, **4**, 191–2 (1951).

The first volume is to be published in June, 1951, and will contain crystal descriptions and angles of approx. 3 000 compounds of the tetragonal, hexagonal, trigonal and orthorhombic systems.

548.24 : 548.73

3903. Barium titanate twinning at low temperatures. R. G. RHODES. *Acta Cryst.*, **4**, 105–10 (*March*, 1951).

The phase transitions of $BaTiO_3$ single crystals have been investigated by means of X-rays from room temperature to −160°C. Below the second transition at about 0°C, crystals which were single at room temperature became highly twinned. Likewise, a complicated twinning occurred below the third transition at approximately −90°C. The temperature variation of the axial parameters and of the unit-cell volume has been measured from X-ray diffraction photographs, and the symmetry and twinning arrangement of the low-temperature phases have been determined. A.

548.4 : 548.73

3904. The degree of imperfection of crystals. N. W. H. ADDINK. *Rec. Trav. Chim. Pays-Bas*, **70**, 202–8 (*Feb.*, 1951).

An attempt is made to arrange crystals of various materials according to their degree of imperfection, derived from the apparent value of N (the Avogadro number). N has been determined for each kind of crystal according to the formula: $N = cM/Vd$, where M is the molecular weight, c a factor related to the number of molecules per unit cell, V the volume of the unit cell and d the density of the crystal. Metals, in accordance with their mosaic structure, show a relatively high value of N and therefore a high degree of imperfection (0·06% of their volume), whilst the lowest value of N has been found for diamond, quartz, calcite and KCl (prepared from a solution). Special attention is drawn to the behaviour of perfect crystals of KCl (from a solution) and imperfect crystals of the same substance (from the melt); adsorption phenomena of water vapour give rise to an estimation of the thickness of mosaic blocks. A value of 6×10^{-4} cm has been found, assuming a monomolecular layer of water molecules on the internal surface. A.

548.5

3905. A note on the radially symmetrical phase growth controlled by heat conduction. D. GEIST. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 208–9 (*Feb.*, 1951). See Abstr. 6143 (1950).

548.5 : 534.321.9

3906. An experimental investigation of the influence of ultrasonic waves on the kinetics of crystallization. A. P. KAPUSTIN. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 357–65 (1950) *In Russian.*

The influence of ultrasonic radiation (720 kc/s) on the speed of crystallization of organic substances was investigated qualitatively. Organic compounds were used as models for the study of the behaviour of metals. It was found that the speed of a phase transformation could be increased 100 times in an ultrasonic field. By irradiation a very fine grain structure is produced which significantly strengthens the material. Both these effects are thought to be due to oscillation of the grain boundaries. Impurities in an alloy can be removed or concentrated into layers and a zonal structure can be produced in a field of standing waves. Radiation hastens the crystallization of a eutectic and inhibits the formation of columnar structures.

A. L. MACKAY

548.538

3907. Epitaxial crystal growth of silver on rock-salt (110) and (111) faces. L. BRÚ AND M. K. GHARPUREY. *Proc. Phys. Soc., Lond. A*, **64**, 283–6 (*March*, 1951).

It has long been known that Ag can grow epitaxially on a rock-salt cleavage face. It has now been found by electron diffraction that it also grows in parallel orientation on (110) and (111) faces of rock-salt and that the Ag crystals are twinned repeatedly on their {111} faces. A new example of rotational slip has been noted in which Ag crystals were found to have slipped rotationally on their {110} planes. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

3908. A theory of the transformation in pure cobalt. J. W. CHRISTIAN. *Proc. Roy. Soc. A*, **206**, 51–64 (*March* 22, 1950).

The suggestion that the faults in hexagonal Co are in thermal equilibrium with the structure and that

the phase change in pure Co is influenced considerably by surface energy is examined. It is shown that for the pseudo-equilibrium of a number of individual crystals surface energy effects could produce transformation over a temperature range, but the other effects of the transformation are not explained. Quantitative results for the number of hexagonal faults show that these cannot be in thermal equilibrium. The transformation in Co is martensitic in nature and the mechanism is considered in terms of "half dislocations" of the face-centred-cubic (f.c.c.) lattice. It is shown qualitatively that in the case of these dislocations reflection at a free surface can lead to the production of a twinned structure or, under favourable conditions, to the transformation from f.c.c. to close-packed-hexagonal (c.p.h.). The faults in hexagonal Co can be considered to be the result of "wrong" reflections during the transformation. The characteristic features of martensitic transformations can be explained in terms of the dislocation mechanism.

A.

548.7

3909. Theory of order-disorder modifications in binary alloys. G. Fournet. *C.R. Acad. Sci., Paris*, **232**, 155–7 (*Jan.* 8, 1951) *In French.*

An application of the general theory of Yvon [Abstr. 1702 (1948)]. Considers the interaction energies of pairs of atoms involving nearest and next-nearest neighbours. The results are fitted to give good agreement with experimental values of the specific heat just below the critical temperature for alloys of equiatomic composition and body-centred cubic structure.

H. P. MYERS

548.7

3910. Long-range order in beta-brass and Cu_3Au. D. T. Keating and B. E. Warren. *J. Appl. Phys.*, **22**, 286–90 (*March*, 1951).

Measurements have been made on single crystals of CuZn and Cu_3Au held at various temperatures below T_c to decide whether there is a single-ordered phase whose order changes with temperature, or whether there is an ordered and a disordered phase the relative amounts changing with temperature. Precision measurements were made of the position and width of the (222) CuZn and (400) Cu_3Au reflections. The disordered phase has a larger cell dimension, so that reflections from the ordered and disordered phases are slightly displaced from one another. For both materials, a single peak was observed which was too narrow to correspond to the existence of two phases. At the stoichiometric compositions, it is concluded that below T_c there is only an ordered phase whose long-range order varies with temperature. Measurements of the long-range order in Cu_3Au have been made on briquets of filings, using quenched samples, and on a sample held at temperature.

A.

548.7 : 535.371

On the origin of fluorescence in diamond. *See Abstr.* 3456

548.7 : 539.11

A quantum mechanical treatment of the lithium fluoride crystals. *See Abstr.* 3681

548.7 : 541.123.2

3911. Phase equilibria in an ordering alloy system. J. B. Newkirk, R. Smoluchowski, A. H. Geisler and D. L. Martin. *J. Appl. Phys.*, **22**, 290–8 (*March*, 1951).

The equilibria between phases in Pt alloys containing 42, 48 and 54 atomic % Co were determined at temperatures below 1 000°c. This system of alloys exhibits an order-disorder transition analogous to that for CuAu. A temperature range in which ordered and disordered phases coexist in equilibrium was determined for each alloy. These data were incorporated in the phase diagram. The Co–Pt system is the first ordering alloy system in which it has been shown that this reaction is a true phase transformation contrary to the prevalent concepts of the phenomena.

A.

548.7 : 541.123.2

3912. The crystal structure of the sigma-phase in the Co–Cr system. J. S. Kasper, B. F. Decker and J. R. Belanger. Letter in *J. Appl. Phys.*, **22**, 361–2 (*March*, 1951).

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 3803–12

548.732.2 : 535.343.2 : 537.531

X-ray absorption in crystals set at the Bragg angle. *See Abstr.* 3553

548.733

3913. The production of diffraction effects from polycrystalline material using an X-ray flash tube. W. Schaaffs. *Z. Naturforsch.*, **5a**, 631–2 (*Nov.*, 1950) *In German.*

Describes two experimental arrangements. The first, in which the anode is cone-shaped, will give diffraction photographs of well-developed crystals in a single flash, of duration about 10^{-6} sec. The second, which has a rod-shaped target, will give a photograph of a polycrystalline material in a similar flash. In each case a divergent beam is employed and in the second case a focusing method is used. The shape of the target in this case ensures that as many as possible of the X-rays produced are utilized.

J. THEWLIS

548.733

3914. The X-ray photography of volatile or deliquescent single crystals. F. J. Llewellyn. Note in *Acta Cryst.*, **4**, 185 (*March*, 1951).

548.733

3915. Powder diffraction patterns from micro samples. L. K. Frevel and H. C. Anderson. Note in *Acta Cryst.*, **4**, 186 (*March*, 1951).

548.733

3916. Utilization of the Bragg–Brentano method with sealed fine focus tube. H. Brasseur. Note in *Acta Cryst.*, **4**, 189 (*March*, 1951) *In French.*

548.734.4

3917. A simple method of applying the rotation factor correction in equi-inclination Weissenberg photographs. F. H. Herbstein. *Acta Cryst.*, **4**, 185 (*March*, 1951).

548.735

3918. Contribution to the study of X-ray microscopy. IV. Structure of rutile (TiO_2). L. Brú, M. Cubero and R. Vega. *An. Real. Soc. Esp. Fis. y Quím.*, **46**, 317–20 (*Nov.–Dec.*, 1950) *In Spanish.*

See Abstr. 7611 (1950) for Part III. Good agree-

ment between the optical and X-ray diffraction patterns is obtained. A. J. C. WILSON

548.735

3919. Method for the determination of the position of the heavy atoms in the study of crystal structures. L. RIVOIR AND M. ABBAD. *An. Real. Soc. Esp. Fis. y Quim.*, **46**, 321–2 (*Nov.–Dec.*, 1950) *In Spanish.*

The co-ordinates of dominant heavy atoms are sometimes determinable from observed systematic absences not required by the space group.

A. J. C. WILSON

548.735.4

3920. A circular slide rule for structure-factor calculations. G. M. J. SCHMIDT. Note in *Acta Cryst.*, **4**, 186–7 (*March*, 1951).

548.735.4

3921. A note on the solution of the structure-factor equations. J. KARLE AND H. HAUPTMAN. Note in *Acta Cryst.*, **4**, 188–9 (*March*, 1951).

548.735.4

3922. Method for determining the signs of the structure factors of long-chain compounds. V. VAND. *Acta Cryst.*, **4**, 104–5 (*March*, 1951).

Crystals of certain molecules show periodicities within their unit cell, which can be described by a much smaller subcell. By means of a relation between the structure factors of the main cell and the subcell, the structure of the subcell can be determined and from this information the solution of the main-cell structure obtained. A.

548.735.46

3923. On the maxima of the Patterson functions. P. HARTMAN AND A. WINTNER. *Phys. Rev.*, **81**, 271–3 (*Jan.* 15, 1951).

For the case of a 1-dimensional crystal (and, therefore, in 3 dimensions as well) it is possible to construct a counter-example, realizing the following situation: the electron density is the sum of 2 monatomic distributions, but the number of peaks in Patterson's diagram exceeds 3, whereas the standard rule would claim at most 3 such peaks. Consequently, the usual "addition rule of peaks" is false as a general mathematical theorem. It follows that the explanation of the empirical success of this rule in crystallography lacks to date a mathematical basis, that is, a non-empirical foundation. A.

548.736.1

3924. The crystal structure of α-monoclinic selenium. R. D. BURBANK. *Acta Cryst.*, **4**, 140–8 (*March*, 1951).

The crystal structure has been determined by the application of the Harker–Kasper phase inequalities and two-dimensional Fourier syntheses. The α-Se molecule is an eight-membered, puckered ring similar to the rhombic S molecule. It conforms, within the limit of experimental error, to the non-crystallographic point-group symmetry $\bar{8}2m$; the covalent bond distance is $2{\cdot}34 \pm 0{\cdot}02$ Å, and the covalent bond angle is $105{\cdot}3 \pm 2{\cdot}3°$. Certain abnormally short packing distances are observed which are discussed in terms of the metallic character believed to be present in the intermolecular bonding of hexagonal Se. A.

548.736.3

3925. The crystal structure of ferric bromide. N. W. GREGORY. *J. Amer. Chem. Soc.*, **73**, 472–3 (*Jan.*, 1951).

548.736.3

3926. Disagreement between crystal symmetry and X-ray diffraction data as shown by a new type of silicon carbide, 10*H*. L. S. RAMSDELL AND J. A. KOHN. *Acta Cryst.*, **4**, 111–13 (*March*, 1951).

548.736.3

3927. Interatomic distances in Co_2Al_9. L. PAULING. *Acta Cryst.*, **4**, 138–40 (*March*, 1951).

It is pointed out that the system of metallic radii leads to interatomic distances in good agreement with those observed for the compound Co_2Al_9. [Abstr. 3532 (1950)]. A.

548.736.3

3928. The structure of potassium fluoride dihydrate. T. H. ANDERSON AND E. C. LINGAFELTER. Note in *Acta Cryst.*, **4**, 181–2 (*March*, 1951).

548.736.4

3929. X-ray study of the phase transition in lead titanate. G. SHIRANE, S. HOSHINO AND K. SUZUKI. Letter in *Phys. Rev.*, **80**, 1105–6 (*Dec.* 15, 1950).

It is shown that the structure of $PbTiO_3$ changes from tetragonal to cubic at 490°C. As the temperature rises from 30°C the volume of the unit cell decreases slightly and during the transitional region it diminishes nearly discontinuously. A. E. DE BARR

548.736.4

3930. The crystal structure of ammoniumtetrametaphosphate, $(NH_4)_4P_4O_{12}$. C. ROMERS, J. A. A. KETELAAR AND C. H. MACGILLAVRY. *Acta Cryst.*, **4**, 114–20 (*March*, 1951).

The crystal is shown by X-ray analysis to be built from tetramer anions P_4O_{12}, and from NH_4 ions. Anions and cations form alternating layers parallel to (010). The NH_4 ions form H bonds with O atoms in roughly tetrahedral directions. P–O distances show the same general features as in P_2O_5 and related compounds. A.

548.736.4

3931. Crystal structure of anhydrous nitric acid. V. LUZZATI. *Acta Cryst.*, **4**, 120–31 (*March*, 1951) *In French.*

Anhydrous HNO_3 crystallizes at $-41{\cdot}6$°C. Bouttier's method has been used for the preparation and the transport of the crystals, and Weissenberg diagrams of several layer lines have been obtained, using rotation about the three crystallographic axes. The unit cell is given by the three orthogonal translations $a = 16{\cdot}23$, $b = 8{\cdot}57$, $c = 6{\cdot}31$ Å, and contains 16 molecules NHO_3. The group of symmetry is $P2_1/a$–C_{2h}^5 in the monoclinic system, with $\beta = 90°$. The crystals obtained showed submicroscopic twinning. The atomic parameters were obtained from three projections of the electron density. Continuous streaks are observed along some lines in the reciprocal lattice. An interpretation of these in terms of a certain disorder in the structure is suggested. A.

548.736.4

3932. The crystal structures of NiO . 3BaO, NiO . BaO, $BaNiO_3$ and intermediate phases with composition near $Ba_2Ni_2O_5$; with a note on NiO. J. J. LANDER. *Acta Cryst.*, **4**, 148–56 (*March*, 1951).

548.736.5

3933. The crystal structure of KSb_4F_{13} and isomorphous compounds. A. Byström and K.-A. Wilhelmi. *Ark. Kemi*, **3**, *Paper* 3, 17–30 (1951).

Tetragonal, $I4/m$ (less probably $I\bar{4}$), $a = 9{\cdot}636 \pm 5$, $c = 6{\cdot}365 \pm 3$ Å, $Z = 2$. For the isotypic compound with Rb replacing K, $a = 9{\cdot}635$, $c = 6{\cdot}563$; with Cs, $a = 9{\cdot}639$, $c = 6{\cdot}785$; with NH_4, $a = 9{\cdot}643$, $c = 6{\cdot}553$; and with Tl, $a = 9{\cdot}637$, $c = 6{\cdot}584$. Sb has 3 close F neighbours at $\sim 2{\cdot}0$ Å, as in SbF_3, and 2 others at $\sim 3{\cdot}0$ Å. The two space groups differ only in the position of 2 of the F's, and the choice was made on grounds of packing. A. J. C. Wilson

548.736.5

3934. The crystal structure of galenobismutite, $PbBi_2S_4$. F. E. Wickman. *Ark. Min. Geol.*, **1**, *Paper* 9, 219–25 (1951).

Orthorhombic, *Pnma*, $a = 11{\cdot}65 \pm 5$, $b = 4{\cdot}08 \pm 3$, $c = 14{\cdot}49 \pm 5$, $Z = 4$. The positions of Bi and Pb were found from a Patterson projection, those of S largely by packing. The S atoms form a slightly deformed octahedron round Pb, but the co-ordination of Bi is somewhat irregular. A. J. C. Wilson

548.736.5

3935. The structure of Millon's base and its salts. W. N. Lipscomb. *Acta Cryst.*, **4**, 156–8 (*March*, 1951).

The structure of Millon's base, $Hg_2NOH \cdot 2H_2O$, consists of a three-dimensional framework Hg_2N^+ in an idealized cristobalite type of arrangement. The mercury atoms form linear *sp* bonds, while the nitrogen forms tetrahedral sp^3 bonds, in a face-centered cubic lattice with $a = 9{\cdot}58$ Å. The Hg–N bond distance is $2{\cdot}07_3$ Å. A.

548.736.6

3936. The structure of tourmaline. N. V. Belov and E. N. Belova. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 6) 807–10 (1950) *In Russian.*

A detailed criticism is made of the structure of tourmaline as determined by Donnay and Buerger [Abstr. 8343 (1950)] and the correctness of the authors' determination [Abstr. 3545 (1950)] is maintained. The observed intensity data, the Patterson projections, Patterson–Harker sections and implication diagrams from which both pairs of investigators start are identical but the interpretations differ. Mg(Fe) atoms are not found in the positions fixed by Buerger and Donnay, but where they put Al atoms; such an arrangement explains the implication diagram better. Discrepancies between the $a \times c$ and $a\sqrt{(3)} \times c$ Harker sections are pointed out. A. L. MacKay

548.736.6

3937. An orthorhombic variety of chrysotile. E. J. W. Whittaker. Note in *Acta Cryst.*, **4**, 187–8 (*March*, 1951).

548.737

3938. The structures of pyrimidines and purines. V. The electron distribution in adenine hydrochloride. W. Cochran. *Acta Cryst.*, **4**, 81–92 (*March*, 1951).

The electron density in crystals of adenine hydrochloride has been measured with sufficient accuracy to distinguish between a number of possible tautomeric forms of the adenine molecule differing only in the positions assigned to hydrogen atoms. The result is presented as the difference between the electron density in the crystal and that appropriate to an assemblage of atoms whose electron distribution is that calculated by Hartree's self-consistent-field method. It is pointed out that this difference is smaller than might have been expected. The electron distribution in N–N and N–O hydrogen bonds supports the view that in a hydrogen bond the proton is at approximately the normal covalent-bond distance from one atom of the pair. A.

548.737

3939. The structures of pyrimidines and purines. IV. The crystal structure of guanine hydrochloride and its relation to that of adenine hydrochloride. J. M. Broomhead. *Acta Cryst.*, **4**, 92–100 (*March*, 1951).

The crystal structure of guanine hydrochloride monohydrate has been established by X-ray analysis, employing two-dimensional Fourier methods. The cell dimensions and space group are different from those of adenine hydrochloride hemihydrate, but, in spite of this, the two structures are strikingly similar. From the disposition of intermolecular hydrogen bonds an attempt is made to deduce the positions of the hydrogen atoms covalently bound to nitrogen atoms of the purine molecules. A.

548.737

3940. The crystal structure of *p*-aminophenol. C. J. Brown. *Acta Cryst.*, **4**, 100–3 (*March*, 1951).

The structure of crystalline *p*-aminophenol has been determined by the X-ray method. The dimensions of the orthorhombic unit cell, which contains four molecules of $C_6H_4 \cdot (OH) \cdot NH_2$, are $a = 12{\cdot}90 \pm 0{\cdot}03$, $b = 8{\cdot}19 \pm 0{\cdot}03$, $c = 5{\cdot}25 \pm 0{\cdot}03$ Å, and the space group is $P2_1nb$, [*a*] being the polar axis. The calculated specific gravity is 1·305, while that observed by flotation is 1·295. X-ray intensities were obtained from Weissenberg moving-film photographs for all layers of the three principal axes, and the approximate structure was derived by analogy from that of aniline hydrochloride. The atomic co-ordinates were refined by means of successive two- and three-dimensional Fourier syntheses using finally 605 experimental structure amplitudes as coefficients of the series. The bond lengths within the benzene ring are normal but the C–N bond is shorter (1·39 Å) than that given by the sum of the covalent radii. Molecules of *p*-aminophenol are linked together by three hydrogen bonds of length 2·83, 3·13 and 3·18 Å. A.

548.737

3941. The crystal structure of hydrate racemic acid. G. S. Parry. *Acta Cryst.*, **4**, 131–8 (*March*, 1951).

The crystals are triclinic with $a = 8{\cdot}06$, $b = 9{\cdot}60$, $c = 4{\cdot}85$ Å; $\alpha = 70{\cdot}4°$, $\beta = 97{\cdot}2°$, $\gamma = 112{\cdot}5°$. The cell has a centre of symmetry and contains one *d*- and one *l*-tartaric acid molecule and also two water molecules. Atomic parameters have been obtained and refined by two-dimensional electron-density summations. Some phase relations obtained from Harker–Kasper inequalities helped to determine the *z* parameters. The configuration of the tartaric acid

molecule agrees with that found in Rochelle salt and in tartaric acid. The structure is held together by an extensive arrangement of hydrogen bonds, all of which form closed systems. Columns are formed parallel to the *c* axis by square hydrogen-bond systems involving the hydroxyl groups. Hydrogen bonds between carboxyl groups hold these columns together in sheets parallel to $(1\bar{1}0)$, and these sheets are held together by the water molecules. Difficulties arise in the precise location of the hydrogen bonds to the water molecules owing to the close approach of many oxygen atoms. A plane arrangement is favoured although other possibilities exist. A.

548.737

3942. A comparison of X-ray measurements on air-dried tobacco necrosis protein crystals with electron-microscope data. P. COWAN AND D. C. HODGKIN. *Acta Cryst.*, **4**, 160–1 (*March*, 1951).

548.737

3943. The structure of octachlorocyclobutane, C_4Cl_8. T. B. OWEN AND J. L. HOARD. *Acta Cryst.*, **4**, 172–6 (*March*, 1951).

548.737

3944. The crystal structure of *p*-di-tertiary-butylbenzene. B. S. MAGDOFF. *Acta Cryst.*, **4**, 176–9 (*March*, 1951).

548.737

3945. Preliminary study of the structure of citrinin. S. G. CLARKE AND A. J. KING. Note in *Acta Cryst.*, **4**, 182–3 (*March*, 1951).

548.737 : 535.323

3946. The monohydrate of ethylenediamine *d*-tartrate: optical properties and X-ray diffraction data. E. G. STEWARD. Note in *Acta Cryst.*, **4**, 184 (*March*, 1951).

548.74

3947. Single crystal neutron diffraction analysis. R. D. LOWDE. Letter in *Nature, Lond.*, **167**, 243–4 (*Feb.* 10, 1951).

Describes a new technique for crystal analysis by neutron diffraction which dispenses with the need for a monochromator. A small crystal is used, to overcome difficulties caused by extinction, and the crystal is set at the Bragg angle for any desired plane and wavelength, a B-foil counter being placed in such a position as to receive the diffracted beam. In this way satisfactorily high peak-to-background ratios are obtained and it is suggested that information about hydrogenous organic structures is already within reach of the methods of neutron diffraction, without any need for the substitution of H by D. J. THEWLIS

548.74 : 539.185

3948. Recent application of neutron diffraction. A. H. WEBER. *Nucleonics*, **7**, 31–9 (*Dec.*, 1950).

Reviews several problems where the application of neutron diffraction has proved superior to the X-ray method. Al and graphite, having low slow-neutron-absorption cross-sections, have proved suitable for studies of crystal orientation. The location of H and other light atoms is made possible by their relatively high coherent-neutron-scattering cross-sections and it has been shown, e.g., that the structure of heavy (D_2O) ice conforms to the Pauling half H model. The large difference between the neutron scattering amplitudes of Fe and Co atoms, has made it possible to detect a chemically ordered (super-lattice) structure in FeCo slowly cooled (100 hr) from 750°C. The existence of ordering in the magnetic moments of O atoms in MnO has been established in a sample cooled to 80°K. It would not have been possible to discover this with X-rays owing to the absence of any interaction with the magnetic moments.

L. R. SHEPHERD

GEOPHYSICS 55

550.341

3949. Determination of the constants k and v_0 in the seismological formula $t = 2/k \,.\, \sinh^{-1} kx/2v_0$. H. DE CASTRO. *Cienca, México*, **10** (*No.* 7–8) 221–2 (1950) *In Spanish.*

The equation is transformed into such a form that the method of least squares can be applied.

M. DOPORTO

550.341

3950. On the velocity of propagation of seismic waves over short distances. G. ALIVERTI AND L. SOLAINI. *Ann. Geofis.*, **3**, 485–7 (*Oct.*, 1950) *In Italian.*

Measurements of the velocities of *P* and *S* waves over a distance of *c.* 1 600 m, at depths less than 150 m. E. M. FOURNIER D'ALBE

550.341

3951. Rayleigh waves in a two-layer heterogeneous medium. M. NEWLANDS. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 109–24 (*Oct.*, 1950).

A method is developed for the solution of the equations for Rayleigh waves in a semi-infinite incompressible medium in which a crust of rigidity varying linearly with depth lies on top of a uniform elastic medium of great depth. The method is extended to deal with compressible media and in both cases is applied to a model earth consisting of a crust of depth 37·5 km in which the rigidity increases linearly from $2{\cdot}3\times10^{11}$ to $4{\cdot}53\times10^{11}$ dynes/cm² over the ultrabasic material of infinite depth in which the rigidity is constant and equal to $6{\cdot}47\times10^{11}$ dynes/cm². The applicability of the theory to the problem of microseisms is considered and it seems that it may be found useful in the study of those microseisms of period a fraction of a second. Finally, $\chi^{(1)}$, $\chi^{(2)}$, those solutions of a particular equation which it is found convenient to use here, are related to the appropriate Whittaker confluent hypergeometric function, already known to be a solution. A.

550.341

3952. Theoretical travel-times of *S* waves in the earth's inner core. K. E. BULLEN. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 124–8 (*Oct.*, 1950).

Travel-times have been computed for the phase *PKJKP*, where *J* corresponds to waves of *S* type in the earth's inner core. The calculations are based

on the J.B. tables and on an earth model based on compressibility theory. A.

550.341

3953. The theory and design of two types of portable seismograph. P. L. WILLMORE. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 129–37 (*Oct.*, 1950).

550.831

3954. The second derivative method of gravity interpretation. T. A. ELKINS. *Geophysics*, **16**, 29–50 (*Jan.*, 1951).

The theoretical formula by which it is possible to compute the 2nd (vertical) derivative of any harmonic function from its values in a horizontal plane is derived for both the 2-dimensional and the 3-dimensional cases. The graphical method of computing the 2nd derivative is discussed, especially as to the sources of error. A numerical coefficient equivalent of the graphical method is also presented. Formulae and graphs for the 2nd derivative of the gravity effect of such geometrically simple shapes as the sphere, the infinite horizontal cylinder, the semi-infinite horizontal plane and the vertical fault, are presented with discussions of their value in the interpretation of practical data. Finally, the gravity and 2nd derivative maps of portions of some important oil provinces are presented and compared to show the higher resolving power of the 2nd derivative. A.

550.831 : 550.838

3955. Combined analysis of gravity and magnetic anomalies. G. D. GARLAND. *Geophysics*, **16**, 51–62 (*Jan.*, 1951).

It is shown that the ratio of the anomalous susceptibility to the anomalous density of an unknown body may be determined from gravimeter and vertical magnetometer observations, independent of assumptions as to the depth or form of the body. The use of this ratio in identifying the rock material of the body is discussed, and illustrated by applying the method to a well-known case. A.

550.834

3956. Dispersion in seismic surface waves. M. B. DOBRIN. *Geophysics*, **16**, 63–80 (*Jan.*, 1951).

A non-mathematical summary is presented of the published theories and observations on dispersion, i.e. variation of velocity with frequency, in surface waves from earthquakes and in water-borne waves from shallow-water explosions. Two further instances are cited in which dispersion theory has been used in analysing seismic data. A.

550.834.3

3957. Seismic refraction with variable velocity. J. M. GOGUEL. *Geophysics*, **16**, 81–101 (*Jan.*, 1951).

The results of an investigation of methods of interpreting and calculating the propagation of seismic waves with variable velocity in contrast to an assumed constant velocity is presented. One of the major purposes of this study is to establish a calculation method for use in seismic refraction work that can be applied to existing types of alluvia and similar geologic formations. In addition to presenting the necessary tables and graphs used for such computations, two examples from actual field experience are presented. A.

550.837

3958. The telluric method of prospecting and its limitations under certain geologic conditions. V. S. TUMAN. *Geophysics*, **16**, 102–14 (*Jan.*, 1951).

After general considerations of geophysical methods and the properties of the telluric field, some simple problems are discussed and two factors are introduced: the tectonic factor, ϕ, a function of the geology of the area, estimated roughly from the shape and the orientation of the ellipses; the distorting factor, Ψ, a function of the physical properties of the beds. It is concluded that these factors set a limit in correlating the surface measurements to the actual shape and the size of the structure, and thus a limit to the interpretation of the results of a telluric survey. A.

550.837.3

3959. Theoretical study on the ground resistivity method of electrical prospecting. T. KIYONO. *Mem. Fac. Engng Kyoto Univ.*, **12**, 29–59 (*Jan.*, 1950).

Investigates the constant-depth profile curves obtained for various ground configurations when long parallel-line current electrodes are used. This allows the problem to be treated as a two-dimensional one and so it is possible to utilize the method of conformal transformation. The problems treated are a semi-infinite buried horizontal plate, a semi-infinite buried vertical plate, thin vertical and horizontal plates of finite length, a buried circular cylinder, anticlines and synclines. Particular examples of these cases have been numerically evaluated and the results are given in 26 graphs. J. M. HOUGH

550.93

3960. On the initial abundance of K^{40}. C. FESTA. *Ann. Geofis.*, **3**, 489–99 (*Oct.*, 1950) *In Italian.*

The known relations between nuclear structure and the relative abundance of the elements permit an estimate to be made of the initial abundance of K^{40}. The result, assuming a decay constant $\lambda = 1{\cdot}97 \times 10^{-9}\ \mathrm{yr}^{-1}$, gives for the age of the elements 3×10^9 yr; it also indicates that the contribution of K to the heating of the earth is less important than has previously been supposed. E. M. FOURNIER D'ALBE

550.93 : 539.163.1

3961. Radioactivity of potassium and age of the earth. A. ROSTAGNI. *Geofis. Pura Appl.*, **18** (*No.* 1) 128–31 (1950) *In Italian.*

Recent experiments on the radioactivity of K^{40} give as result: $\lambda = (0{\cdot}60 \pm 0{\cdot}05)10^{-9}\ \mathrm{yr}^{-1}$, $\lambda_K/\lambda = 0{\cdot}10 \pm 0{\cdot}05$, λ_K being the constant of decay by *K*-electron capture, $\lambda = \lambda_\beta + \lambda_K$ the total decay constant. Making the following assumptions: (1) atmospheric argon in the decay product of K^{40} in the earth, which has undergone *K*-capture; (2) the K existing in the earth is practically all contained in the external crust, 10 miles thick; (3) the age of the solid crust does not exceed $\sim 3 \times 10^9$ yr: it is concluded that the earth as a whole must have remained in a fluid state for $\sim 10^9$ yr at least. A.

551.24

3962. Water movement induced by compaction of clastic sediments. R. A. HOWARD AND C. E. BLEIL. Letter in *J. Appl. Phys.*, **22**, 360 (*March*, 1951).

551.311.12 : 550.837.6

3963. Some geoelectric investigations on Austrian glaciers. V. FRITSCH. *Geofis. Pura Appl.*, **17**, 210–13 (*Oct.–Dec.*, 1950) *In German.*

Experiments to determine the thickness of glaciers by high frequency prospecting, and electrohydrographical measurements on glacier rivulets were carried out. The resistance of the glacier water fluctuates according to the time of season, depending on the composition. The geologic and mineralogic properties of the glacier water may thus be deduced, especially the amount of surface water. A.

551.311.182 : 535.39

3964. The spectroscopic transparency of ice. F. SAUBERER. *Wetter u. Leben*, **2** (*No.* 9–10) 193–7 (*March*, 1950) *In German.*

Figures of % transparency per m and per cm are given for ice and for water for wavelengths ranging from 300 to 1 300 mμ. Transparency to i.r. is difficult to measure but agrees in general with that of water. METEOROLOGICAL ABSTRACTS

551.465 : 532.593

The application of conformal transformations to ocean wave refraction problems. *See Abstr.* 3379

ATMOSPHERE . METEOROLOGY 551.5

551.501

3965. Reviews of modern meteorology. I. Meteorological measurements. A. W. BREWER AND F. J. SCRASE. *Quart. J. Roy. Met. Soc.*, **77**, 3–32 (*Jan.*, 1951).

The authors give a critical review of developments of the last five years under the following headings: Surface pressure; surface wind; visibility; upper wind; radio-sondes; high-altitude balloons; measurements from aircraft; thunderstorm location; radiation; ozone; infrared absorption; high-atmosphere measurements; cloud physics; drop-size; condensation and freezing nuclei; turbulence (70 refs.).

551.508.11

3966. Development and utilization of constant-level balloons. W. D. MURRAY, C. S. SCHNEIDER AND J. R. SMITH. *Trans Amer. Geophys. Un.*, **31**, 843–8 (*Dec.*, 1950).

551.508.19

3967. An improved fully electric radiosonde. K. SITTEL AND E. MENZER. *Bull. Amer. Met. Soc.*, **31**, 341–6 (*Nov.*, 1950).

A fully electric radiosonde using the Finnish principle is described. The temperature is measured with a temperature-sensitive dielectric; the humidity by the determination of the psychrometric difference; and the pressure by a corrugated diaphragm which positions a cylindrical condenser. The measuring elements and the construction of the sonde, as well as the calibration and receiving station, are outlined. The more important phases of the investigation are briefly mentioned, and a comparison of the temperature measurement with a number of other sondes is given. A.

551.508.19 : 551.510.535 : 621.396.615.17

3968. A time base circuit for a high precision ionospheric sounding apparatus. B. M. BANERJEE AND R. ROY. *Indian J. Phys.*, **24**, 411–19 (*Sept.*, 1950).

This time-base circuit produces a 10-line raster on the face of the c.r.t. Each line of the raster takes 333 μsec, which corresponds to 50 km of ionospheric height. This gives a reading accuracy of about $\frac{1}{4}$ km. The time base provides for 15 kc/s positive and negative marker pips which mark off 5 km intervals. It also provides for an intensifying pulse on the grid of the c.r.t. over the 333 μsec interval corresponding to any one of the 10 lines selected by a line-selector arrangement. A.

551.508.71

3969. A sensitive vapour pressure recorder. W. C. SWINBANK. *J. Sci. Instrum.*, **28**, 86–9 (*March*, 1951).

Using very fine dry- and wet-bulb thermo-junctions an instrument has been designed which, by simulating electrically the behaviour of the psychrometric equation for small changes in the variables, provides a means of recording the fine structure of atmospheric vapour pressure. In its present form the instrument provides a record of the vapour pressure fluctuations above some arbitrary level, but it could be adapted for use as a probe for recording actual vapour pressures in confined spaces. A.

551.508.77

3970. A new recording raingauge. A. HAUER. *J. Sci. Instrum.*, **28**, 84–5 (*March*, 1951).

An automatic siphon raingauge is described. The instrument is a floatgauge which when filled to a certain level is emptied by a tilting tube. The construction makes it impossible for preliminary dribbling of the rainwater to occur. The instrument has few moving parts and its functioning cannot be easily spoiled by dirt or corrosion. A.

551.508.822 : 551.521.1

3971. Solar radiation intensity at the ascending radiosonde. V. VÄISÄLÄ. *Geophysica, Helsinki*, **3**, 39–55 (1948).

In a previous calculation of the radiation error of the Väisälä radiosonde the author assumed a constant radiation intensity in the stratosphere. Since this assumption is not warranted, especially when the sun is at a low angle, calculations have been made of the air mass which a beam would traverse at different solar angles and air pressures before striking the instrument. These computed values are represented in tables and as isopleths on charts. A polytropic troposphere (up to 200 mb) and an isothermal stratosphere (from 200 to 10 mb) and a constant relative humidity of 50% in the stratosphere is assumed. After computing water mass at various levels from 1 000 to 250 mb, and extinction of radiation intensity by pure air, the author calculates the extinction and absorption by water vapour.

METEOROLOGICAL ABSTRACTS

551.51

3972. The earth's atmosphere. J. HUMPHRIES. *J. Brit. Interplan. Soc.*, **10**, 18–26 (*Jan.*, 1951).

Review article. Summarizes present knowledge of the composition, temperature and density of the atmosphere, with particular reference to its upper levels. A. C. CLARKE

551.510.5

3973. Nomenclature of the upper atmosphere. N. C. GERSON AND J. KAPLAN. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 200 (1951).

Comments. See Abstr. 1535, 2201 (1951).

551.510.5

3974. Upper atmospheric nomenclature. S. CHAPMAN. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 201 (1951).

Addendum, Abstr. 1535, 2201 (1951). The name turbosphere is proposed for the region from the ground upwards, in which turbulent mixing is more powerful than diffusion. The upper limit of the turbosphere, the turbopause, may or may not be the same as the homopause. A.

551.510.5

3975. Vertical distribution of atmospheric ozone. V. H. REGENER. Letter in *Nature, Lond.*, **167**, 276–7 (*Feb.* 17, 1951).

551.510.535

3976. Tides in the ionosphere. A. P. MITRA. *Indian J. Phys.*, **24**, 387–404 (*Sept.*, 1950).

The paper presents in a connected form results of recent investigations, both theoretical and experimental, on tidal effects in the ionosphere. An account of the electromagnetic theory of tides, as developed by Martyn, is given. Results of estimation of ionospheric tides by comparative study of ionospheric data at Calcutta, Delhi and Chunking are also presented. A.

551.510.535

3977. On the approximate zoning of the F2 layer ionization from the world-wide standpoint. K. RAWER. *C.R. Acad. Sci., Paris*, **232**, 98–100 (*Jan.* 3, 1951) *In French.*

The world-wide distribution of F2 ionization can, with sufficient accuracy, be represented by two zones, east and west, with linear interpolation for the two intermediate zones. The choice of zones is governed by the lines of magnetic dip and this also explains the apparent "continental" influence on ionization in this region. W. J. G. BEYNON

551.510.535

3978. Effects of the atmospheric scale height gradient on the variation of ionization and short wave absorption. M. NICOLET. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 141–6 (1951).

A discussion of the effect of a variable atmospheric scale height is given. A linear gradient of the scale height is used and it is found that special conditions for ionized layer formation are possible. Also, the variation of the layer critical frequency with the altitude of the sun above the horizon and of the short wave absorption are found to be affected by the variation of the scale height. The scale height variation is involved in expressions for the absorption of the solar radiation and the electronic recombination coefficient. A.

551.510.535 : 523.165

Effects of ionosphere on radio waves from the galaxy. *See Abstr.* 3271

551.510.535 : 523.74 : 621.396.11

3979. Ionospheric effects of solar flares. M. A. ELLISON. *Publ. Roy. Obs. Edinburgh*, **1** (*No.* 4) 53–72 (1950).

Detailed description of a study of solar flares and associated terrestrial phenomena during the year 1949. Phenomena considered are short-wave fadeouts, long-wave phase anomalies, atmospheric enhancements and magnetic crochets. These are discussed in relation to Hα intensity of the flares, line widths and areas of emission patches on the solar disk.

W. J. G. BEYNON

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 3668–3670

551.510.535 : 551.524.7

3980. Thermal separation of ionospheric layers. O. BURKARD. *Arch. Met., Geophys. Bioklimatol. Ser. A*, **2** (*No.* 2–3) 308–14 (1950) *In German, summaries in English and French.*

An investigation into the causes of the ionospheric layers, considering vertical temperature, pressure and radiation distribution which is known or assumed at present. Mathematical calculations lead to conclusion that splitting is due to thermal considerations, but theory is not in complete harmony with observation. METEOROLOGICAL ABSTRACTS

551.513

3981. An investigation of diffusion processes in the atmosphere. G. HEINRICH AND A. KLEMENC. *Acta Phys. Austriaca*, **4** (*No.* 2–3) 160–9 (1950) *In German.*

The variation of concentration with height of the different constituents of the atmosphere is calculated from classical mechanics. Applying the result to He, using an experimental value at ground level and assuming a temp. of 0°c at all heights, the He content at 80 km is calculated on the assumption that (*a*) there is a diffusion current, (*b*) there is no diffusion current. Since the results are experimentally indistinguishable, it is concluded that measurements of He concentration will not furnish conclusive evidence for or against the diffusion stream theory. N. CORCORAN

551.513 : 532.51

Equations of general atmospheric circulation. *See Abstr.* 3362

551.521

3982. On radiation of the sky in Finland. H. LUNELUND AND S. NORDSTRÖM. *Geophysica, Helsinki*, **3**, 80–8 (1948) *In German, summary in English.*

The relation between diffuse and total radiation for clear days at different solar heights is discussed and illustrated by means of tables and charts. Measurements of short wave radiation were begun at Rovanieme (66°30′) in 1927 and at Jämsö (61°52′) and Raivola (60°15′), as well as Helsinki, using cadmium-cell photometers. In 1934 u.v.-dosimeter measurements were made at Ilmala and Dalsvik (in and near Helsinki). METEOROLOGICAL ABSTRACTS

551.521.1

3983. On the analysis of observations of solar radiation. K. WEGENER. *Geofis. Pura Appl.*, **18** (*No.* 1) 155–7 (1950) *In German.*

The method of the equilibrium of radiation is demonstrated on two observed series of observations. A.

551.574.1 : 551.576.11 : 551.578.1

3984. Observations of rain from non-freezing clouds. E. J. SMITH. *Quart. J. Roy. Met. Soc.*, **77**, 33–43 (*Jan.*, 1951).

A description is given of observations made in south-east Australia of medium and heavy rain falling from clouds which were everywhere warmer than 0°C. Detailed observations were made visually from aircraft and these were supplemented by measurements of the radar echo intensities and drop size spectra within the clouds. The clouds were all deep cumulus and were over or near the sea. Great concentrations of relatively large water drops were observed in the upper levels of the clouds. A.

551.578.1 : 532.69

The behavior of water drops at terminal velocity in air. *See Abstr.* 3382

551.578.1 : 621.396.9

3985. Radar observations of rain and their relation to mechanisms of rain formation. E. G. BOWEN. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 125–40 (1951).

The radar echoes obtained from rain are known to be of two types, one of which shows a band of high echo intensity just below freezing level, the other a column structure. These echoes have been examined using both ground and airborne radar. The observations have been supplemented by measurements of the temperature structure of the atmosphere and by flight observations of the conditions within the precipitation areas. The results suggest that the two types of echo correspond to two distinct mechanisms of rain formation. The band of high echo intensity occurs when rain forms by the Bergeron process. Flight observations confirm that it is due to the melting of ice particles as they fall past the 0° isotherm. In addition, other radar bands are observed to form at heights in the atmosphere where the temperature is in the vicinity of 16°C. The properties of these bands are described and it is concluded that they are due to the spontaneous freezing of relatively large drops in the cloud. The column type echoes occur in convective clouds and their characteristics are found to be entirely different. Even in clouds which extend some thousands of feet above freezing level, ice and snow particles are not involved and the precipitation consists entirely of water drops. Their properties are similar to those of rain from non-freezing clouds and are consistent with the rain having formed by the coalescence process. A.

551.578.11

3986. A case of the enlargement of cloud drops by fusion. L. KRYSTANOV. *Dokl. Akad. Nauk, SSSR*, **76** (*No.* 1) 53–6 (1951) *In Russian.*

Starting from Ya. I. Frenkel's explanation of gravitational coagulation, consequent upon drops of more than average dimensions falling with greater velocity than the smaller ones and enlarging by fusion on the way, the article enquires into the relations between the dimensions and velocity of an increasing drop and the time taken to coagulate when the original dimensions of the falling drop, the humidity of the cloud and the latter's dimensions are known. Stock's law, according to Frenkel, leads to the paradoxical conclusion that the radius of the drop becomes infinitely great during the finite time of its fall. Hence the formula cannot be applied to comparatively large drops falling at high velocity. A formula is obtained for the time of increase of the drop radius from R_0 to R. When the humidity tends to 0, coagulation time tends to infinity, and the greater the frontal resistance the less the velocity and the longer the coagulation time; while if frontal resistance remains constant the formula can be applied with very great accuracy to drops of any dimensions. J. CLEUGH

551.591.1 : 535.43

3987. The transmission of the turbid atmosphere for infrared rays. H. GAERTNER. *Z. Ver. dtsch. Ing.* [*VDI*] **93**, 113–17 (*Feb.* 11, 1951) *In German.*

The scattering of radiation by gas molecules, dust and water drops is proportional to the square of the particle radius ρ if this is large compared with the wavelength λ in question. For a given ρ scattering is nearly constant as λ increases until it approaches ρ, when it oscillates with a max. at $\lambda = \rho$. Thereafter the scattering declines rapidly, being in accordance with Rayleigh's law when $\lambda > 2\rho$. Hence infrared is of limited use for penetrating fog or mist because for the large particles (up to 60 μ) normally found the region of uniform scattering includes visible wavelengths and also the i.r. down to about 15 μ, beyond which absorption by water vapour is complete. In practice i.r. is advantageous only if visibility is at least 1 km. Infrared-sensitive photocells are referred to, and descriptions given of an i.r. camera-theodolite with an accuracy of 25 m in 90 km distances, and of an extreme-distance camera with mirror objective, having a 25 cm aperture to the main parabolic mirror and a focal length variable between 17 and 34 m. S. T. HENDERSON

551.591.36

3988. Atmospheric transmission in the 1 to 14 μ region. H. A. GEBBIE, W. R. HARDING, C. HILSUM, A. W. PRYCE AND V. ROBERTS. *Proc. Roy. Soc. A*, **206**, 87–107 (*March* 22, 1950).

This has been determined at sea-level, and its dependence on meteorological conditions investigated. Measurements have been made over paths of 2 264 and 4 478 yd, and the correlation with visibility and humidity studied in detail at 4 chosen wavelengths, 2·18, 3·61, 10·01 and 11·48 μ. Spectral transmission curves for typical conditions have been recorded for the complete range 1 to 14 μ and, in addition to the numerous absorption bands due to water vapour and CO_2, some bands caused by the rarer constituents, in particular N_2O and HDO, have been observed. Throughout the wavelength range investigated, the transmission varies with the visibility, the effect being less marked at the longer wavelengths. At 10·01 μ there is a strong dependence on the quantity of water vapour in the path. Assuming that the observed variations are due to the scattering of radiation by salt nuclei the characteristics of a suitable size distribution have been calculated. As the humidity increases the nuclei absorb moisture and increase in size. A.

551.593.54

3989. The role of haze and ice particles in the atmosphere in the scattering of light. K. BULLRICH.

Dtsch. Wetterdienst U.S. Zone, Ber. (*No.* 12) 92–3 (1950).

Comparison of theoretical values of scatter function with those observed by several investigators shows very different results according to number, size and transparency of particles. Sometimes there is almost exclusively forward scattering, due to ice particles.

METEOROLOGICAL ABSTRACTS

551.593.63

3990. On the theory of marginal refraction in ice clouds. R. MEYER. *Dtsch. Wetterdienst U.S. Zone, Ber.* (*No.* 12) 182–4 (1950).

The rapid decrease of light at the margin of the sun attributed to rare but large ice crystals is examined quantitatively in relation to a theory of Bullrich and Möller, which is confirmed.

METEOROLOGICAL ABSTRACTS

551.593.9

3991. Concerning the radiation and absorption of light in various layers of the atmosphere. S. F. RODIONOV. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **14** (*No.* 3) 247–56 (1950) *In Russian.*

Gives a series of experimental results concerning the distribution of the i.r. radiation from the night sky. Also further results on the anomalous transparency in the u.v., reported by the author.

E. P. GEORGE

551.593.9

3992. Identification of the infrared emission of the night sky with the vibration-rotation lines of the hydroxyl OH molecule. I. S. SHKLOVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **75** (*No.* 3) 371–4 (1950) *In Russian.*

The vibrational levels of OH are $\nu = 3\,734{\cdot}9\,(n+\frac{1}{2}) - 82{\cdot}6(n+\frac{1}{2})^2$, $n < 10$, and the rotational structure follows from the usual equation. Hence the rotation-vibration spectrum of OH for $\lambda = 8\,800$–$11\,000$ Å is calculated. To every intensity maximum of the infrared sky-emission correspond definite lines of the OH spectrum, except a weak O-emission line at 8 650 Å.

J. JACOBS

551.593.9

3993. Study of the emission spectrum of the night sky, from 6 800 Å to 9 000 Å. J. DUFAY AND M. DUFAY. *C.R. Acad. Sci., Paris*, **232**, 426–8 (*Jan.* 29, 1951) *In French.*

From spectrograms of the n.s. light in vis. and near i.r. regions, max. intensity measures of the *R* branches in the (5,1), (6,1), (6,2), (8,3) and (9,4) rotational bands of OH give a prob. temperature between 255° and 270°K at *c.* 70 km. Measures from the (0,1) band of O_2 yield a lower temperature, viz. 130°K. These results are in good agreement with Meinel's, who finds 260°K for OH and 150°K for O_2. D. R. BARBER

551.593.9

3994. Rotational structure in the *R* branch of the atmospheric nitrous oxide band at 8·6 μ. A. ADEL. Note in *Astrophys. J.*, **113**, 222–3 (*Jan.*, 1951).

See Abstr. 8849 (1950).

551.594.11 : 551.588.7

3995. On the dependence of atmospheric electrical potential gradients on the [city] metropolitan location of Vienna. G. F. SCHILLING ABD H. SEPER. *Arch. Met. Geophys. Bioklimatol. Ser. A*, **2** (*No.* 2–3) 334–41 (1950).

Effect of houses, buildings and traffic on potential gradient is shown by observations made along a radius from the edge of Vienna to the centre of the city on Oct. 1, 1947. It is shown that the potential gradient increases and the electrical conductivity decreases proportionally as one goes toward the centre. This explains the high conductivity at the Zentralanstalt where continuous records are made, since the observatory is in a park area. METEOROLOGICAL ABSTRACTS

551.594.21 : 550.37

3996. Thunderstorms and the earth's general electrification. O. H. GISH AND G. R. WAIT. *J. Geophys. Res.*, **55**, 473–84 (*Dec.*, 1950).

With the aid of a specially equipped aircraft the conductivity of the air and the vertical component of the electric field strength are registered in regions where strong radar echoes indicate the presence of electrified clouds. The recording instruments employed are described. The variation of the air conductivity is plotted from ground level to about 50 000 ft. Specimen records show the variation of the field strength during individual test flights, the max. value recorded amounting to about 1 000 V/cm. In one particular case the field strength registered at an altitude of 43 000 ft is consistent with the assumption of a bi-polar cloud with a neg. charge of 39 C at 10 000 ft and a corresponding pos. charge centre at 20 000 ft. The mean air current due to a complete thunderstorm is found to vary from 0 to 6·5 A with an average value of 0·5 A. By relating this current to the total number of thunderstorms over the globe it is concluded that this current is adequate to maintain the universal negative electric field of the earth.

R. H. GOLDE

551.594.25 : 551.578.11

3997. The electric charges and masses of single raindrops. W. C. A. HUTCHINSON AND J. A. CHALMERS. *Quart. J. Roy. Met. Soc.*, **77**, 85–95 (*Jan.*, 1951).

Raindrops were admitted by a cone-shaped opening into an insulated vessel connected to a valve amplifier for measuring the drop charge Q. Drop radius a was found by the absorbent paper method. The field at the ground and the point discharge current I were also measured. Most often, but not always, the signs of the drop charge and field were opposite. During point discharge, 173 drop charges and masses were measured, and statistical analysis showed a definite correlation between Q and $-I$, a probable correlation between $Q/-I$ and a and a possible correlation between a and $-Q$. By grouping drops according to radius, and taking averages within the groups, the approximate relationship $Q/-I \propto a$ was obtained. In one period when the radius was nearly constant, the observations gave the connection $Q \propto -I$ without taking averages. The observed relation between Q and I corresponds to the results of Simpson for the charge on a volume of rain. The observed charges were mostly much higher than predicted on Wilson's ion-capture theory, unless the field increases considerably with height in the atmosphere. A.

551.594.5

3998. Notes on aurorae and magnetic storms. I. Considerations as to a model experiment. S.

CHAPMAN. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 189–99 (1951).

A laboratory experiment is proposed, to throw light on the production of aurorae and magnetic storms, by the projection towards the earth, from the sun, of a large volume of neutral ionized gas, consisting mainly of atomic hydrogen. The change of scale in discharge and time, in the model experiment, is discussed on the basis of the Chapman–Ferraro theory. The experiment should reveal the changing form of the hollow formed in the gas, as it flows round the earth, and the associated auroral and magnetic effects: but not the increase of speed of the auroral particles by an electric field within the hollow. The predicted scaler elations apply to the first phase of the storm, but it is hoped that the experiment will throw light also on the main phase. A.

551.594.5

3999. Correlation of auroral observations in the northern and southern hemispheres. D. E. LITTLE AND G. M. SHRUM. *Trans Roy. Soc. Can.*, **44**, 51–6 (*June*, 1950).

Statistical studies of 498 aurorae observed as Borealis and Australis on the same Greenwich date (between 0 hr and 12 hr G.M.T.) yield a probability of occurrence, 0·15, with a significant degree of interdependence since, for random coincidence, the probability will be 0·10. Yet parallel analyses of coincident aurorae, on an intensity basis, fail to reveal a marked connection between great displays in N and S auroral zones. D. R. BARBER

551.594.5

4000. Doppler-shifted auroral hydrogen emission. A. B. MEINEL. *Astrophys. J.*, **113**, 50–9 (*Jan.*, 1951).

Spectra obtained during the intense auroral storm of August 18 and 19, 1950, showed that the Hα emission observed at the magnetic zenith is asymmetrically displaced to the violet. The violet wing is shifted approximately 71 Å, indicating a velocity of impact of 3 300 km/sec. The Hα emission observed at the magnetic horizon is symmetrical and undisplaced but considerably broadened. These observations clearly establish that protons precipitate into the upper atmosphere during auroral storms. These protons must provide the primary energy source for the auroral emissions. A.

551.594.5 : 537.534

4001. Protons and the aurora. G. W. GARTLEIN. Letter in *Nature, Lond.*, **167**, 277 (*Feb.* 17, 1951).

One of two spectrograms of an auroral arc of mod. intensity photographed from 2 stations, 330 km apart, exhibits asymmetric broadening of the Hα line, indicating a max. violet shift of $\geqslant 30$ Å, or a velocity of 1 350 km/sec. The second spectrogram shows symmetrical broadening equal in amount to that previously observed, viz. 10 Å. Since the first exposure was made with the spectrograph pointed along the lines of magnetic force, whilst the second was aimed 90° to the field, it is concluded that the obsd. shift is due to H entering the atmosphere as protons, with mean velocity *c.* 675 km/sec. During an intense display Meinel observed a velocity of 3 200 km/sec, suggestive of a connection between energy of proton stream and magnitude of aurora. D. R. BARBER

551.594.51 : 537.591

4002. On the entry into the earth's atmosphere of 57-keV protons during auroral activity. A. B. MEINEL. *Phys. Rev.*, **80**, 1096–7 (*Dec.* 15, 1950).

With a grating spectrograph pointed toward the magnetic zenith the Hα profile was very asymmetrical and the entire line shifted to the violet. Toward the north magnetic horizon the profile was symmetrical but broadened. The velocity profile of Hα in the zenith is considered as due to the loss of energy of protons entering the atmosphere at 3 300 km/sec at least. W. C. A. HUTCHINSON

551.594.6

4003. Some preliminary studies of the rapid variations in the index of refraction of atmospheric air at microwave frequencies. C. M. CRAIN AND J. R. GERHARDT. *Bull. Amer. Met. Soc.*, **31**, 330–5 (*Nov.*, 1950).

The index of refraction of atmospheric air at microwave frequencies is being measured with equipment which compares the resonant frequency of a cavity through which air is being drawn with that of a closed reference cavity. The equipment is shown to give a measure of the rapid variations of air moisture since the changes in refractive index at these frequencies are primarily a function of air moisture. Preliminary comparisons of the simultaneously recorded fluctuations of microwave index of refraction and air temperature, both measured with equipment whose time constants are considerably smaller than those of the recording Esterline–Angus meters, demonstrate a marked correspondence between air temperature and moisture variations. The correspondence is shown qualitatively to be a function of height, insolation and soil moisture. No immediate correspondence is noted between non-oriented wind speed fluctuations and either air temperature or refractive index. A.

551.594.6

4004. Reflexion of high frequencies during auroral activity. D. DAVIDSON. Letter in *Nature, Lond.*, **167**, 277–8 (*Feb.* 17, 1951).

Note on echo signals from aurora, persisting for some hours, observed during August, 1950, and September, 1946, on frequencies of 17·3 Mc/s and 3·5 Mc/s respectively. W. J. G. BEYNON

551.594.6 : 621.396.11

4005. Some meteorological aspects of radio duct formation. E. KNIGHTING. *Proc. Phys. Soc., Lond. B*, **64**, 21–30 (*Jan.*, 1951).

Three problems are treated. The first concerns the rate of growth of ducts, with special reference to ducts over the sea; it is shown that ducts form quickly at first and then more slowly as the maximum duct width is approached. The second problem concerns the formation of ducts under conditions of nocturnal cooling; it is shown that there is a limit to the height which the duct may attain. The third problem concerns the width of a radio duct necessary to enclose the track width of a mode associated with a propagated signal of wavelength λ assuming a power law of modified refractive index with height; it is shown that the necessary width is proportional to $\lambda^{2/3}$, and the factor of proportionality, which depends upon the index in the assumed power law, is calculated. The

law of turbulent diffusion assumed is that the coefficient of eddy diffusion is proportional to a power of the height, following O. G. Sutton [*Atmospheric Turbulence*, London (1949)] and others. A.

551.596.1

4006. Diffraction effects in the propagation of compressional waves in the atmosphere. N. A. HASKELL. *U.S. Air Force Cambridge Res. Lab., Geophys. Res. Pap.* (*No.* 3) 43 *pp.* (*March*, 1950).

An attempt is made to solve the acoustic wave equation asymptotically, for the case where the velocity of propagation depends only on altitude and there is only one minimum value. This approximate solution is applied to the problem of estimating the temperature at 25 to 60 km on the basis of time of travel for acoustic waves from large explosions to zones of abnormal audibility. The methods, with slight modification, can be equally well applied to problems of long distance, transmission of sound in the ocean, or to particular types of seismic waves. Emphasis is placed on diffraction effects on range and frequency, and useful tables and graphs are included.

METEOROLOGICAL ABSTRACTS

551.596.1 : 534.21

4007. On the propagation of sound over great distances. J. VELDKAMP. *J. Atmos. Terr. Phys.*, **1** (*No.* 3) 147–51 (1951).

The surface energy density of the abnormal sound from big explosions is calculated for a special vertical temperature distribution in the atmosphere. It appears that, in agreement with measurements of Cox *et al.* on abnormal sound from the Heligoland explosion, waves with frequencies as low as 0·1 c/s can be bent back in the ionosphere at a height of 170 km with considerable intensity. Waves with frequencies > 70 c/s are practically totally absorbed in the upper stratosphere. Accurate measurement of the travel-time and intensity of abnormal sound could be used to give information on the temperature and pressure in the ionosphere. A.

BIOLOGY 57/59

578 : 539.163

4008. Report of "Symposium on mode of action of ionising radiations." A. HOWARD. *Nucleonics*, **7**, 26–30 (*Dec.*, 1950).

Summary of papers dealing with the mechanism of the biological action of ionizing radiations, presented at the Sixth International Congress of Radiology, London, July 1950. L. R. SHEPHERD

591.11 : 614.898

4009. Experimental confirmation of an unusual finding in the blood of cyclotron workers. M. INGRAM AND S. W. BARNES. *Science*, **113**, 32–4 (*Jan.* 12, 1951).

In an earlier paper [*Phys. Rev.*, **75**, 1765 (1949)] the authors reported the occurrence of lymphocytes with bilobed or double nuclei in the blood of personnel associated with the 130 in cyclotron of the University of Rochester. Haematological studies have now been made on dogs exposed 50 ft from target while the cyclotron was running. Control experiments on the dogs when the cyclotron was not running showed no significant changes in blood picture. Lymphocytes with bilobed nuclei were detected by oil immersion microscope and $\sim 3 \cdot 3 \times 10^6$ white blood cells were examined. Experimental results show a marked increase in the occurrence of lymphocytes with bilobed nuclei following exposure to radiation from the cyclotron. T. A. CHALMERS

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.844.1

4010. The selective absorption of light by the crystalline lens. F. SALOMON. *Rev. Opt.* (*Théor. Instrum.*) **29**, 632–47 (*Dec.*, 1950) *In French.*

The experimental method, which is said to be still in a state of development, is based on the densitometric evaluation of photographs of the living human lens, illuminated by two narrow pencils of light parallel to its axis; the axis of the camera is at right angles to this. The results obtained with a mercury lamp and filters are fairly reproducible, but the individual variations amongst people even less than 30 years old are marked. 20 figures are presented.

R. A. WEALE

612.85

4011. The watch, standard sound source for the measurement of auditory sensitivity. P. CHAVASSE AND R. LEHMANN. *Ann. Franç. Chronom.* (*Sér.* 2) **4** (*No.* 4) 377–96 (1950) *In French.*

Gives the results of an investigation of the characteristics of watches and chronometers as a simple and universal means of obtaining a rapid and approximate measure of auditory acuity. A table is given showing the respective periods of noise and silence for various types of watches. Problems arising from the sound spectrum analysis of various watches are discussed. In conclusion, the authors derive certain physiological deductions relating to the practical application of the watch and emphasize its very real value as a universal and rapid method of evaluating auditory acuity.

A. B. WOOD

614.898

4012. Sensitivity of the evaporation method of liquid-waste monitoring. F. P. COWAN AND J. V. NEHEMIAS. *Nucleonics*, **7**, 39–45 (*Nov.*, 1950).

Deals with the minimum concentrations of α- and β-activities in the effluent from a sewage processing plant which may be detected by evaporation to dryness of a given volume of the liquid and measurement of the activity of the solid residue. L. R. SHEPHERD

614.898

4013. International recommendations on radiological protection. *Brit. J. Radiol.*, **24**, 46–9 (*Jan.*, 1951); also in *Nucleonics*, **8**, 31–7 (*Jan.*, 1951).

Sixth International Congress of Radiology, London, 1950. Potential hazards have greatly increased

with developments in nuclear physics, though further biological research has brought better realization of the carcinogenic and genetic effects of radiation, and of permissible dosage levels. The proposed new "maximum permissible exposures" emphasize the desirability of reducing dosage from all ionizing radiations to a minimum. The most dangerous effects are those to the blood-forming organs; whole body exposure from radiations up to 3 MeV should not exceed 0·5 r in one week. Frequent blood examinations, systematic measurement of stray radiation, well-ventilated working places, are general necessities. Details of Pb and other materials required for adequate protection in X-ray diagnosis, therapy, and for radium and radon work, are stated. Electrical precautions are given. Risks in radium beam therapy are largely obviated by using remote control. A table shows thickness of lead required to reduce radium beams to permissible levels. See also Abstr. 3554 (1951). D. V. MABBS

615.849 : 621.386.2

4014. A study of the heat distribution in the target of an X-ray tube. M. MATRICON. *J. Phys. Radium*, **12**, 15–25 (*Jan.*, 1951) *In French.*

The treatment is primarily theoretical, but its detailed application to X-ray tube targets under running conditions is made. Expressions for the variation of heat within a solid target, as a function of distance and time, are established: in this, the Laplace transformation is used. By further mathematics, a modified heat distribution formula for a Cu X-ray target surfaced with a W layer is evolved. From this formula, numerical values are deduced for the ratio of the temperatures of Cu and W in the compound target, for various thicknesses of the W layer and for different X-ray exposure times. The W layer is shown to have an optimum thickness which varies according to exposure time and the size of the focal spot. D. V. MABBS

616–073 : 621.386.8 : 621.315.618

4015. Gas insulation. A new trend in roentgen-ray apparatus. M. J. GROSS. *Amer. J. Roentgenol. Radium Ther.*, **65**, 103–8 (*Jan.*, 1951).

Gas has been the insulation of choice in the specialized field of u.h.v. apparatus but has been used in the compressed state ~60 lb/in². SF_6 [see Abstr. 86 B (1949); *Trans Amer. Inst. Elect. Engrs*, **66**, 1463–70 (1947)] has been found a more desirable insulating medium than freon 12. In the last year SF_6 has been applied to 250 kV therapy apparatus and to 100 kV diagnostic apparatus at atmospheric pressure. The spark-over voltage in pure SF_6 is shown to be 2·3–3 times that in pure air. The effects of air and of water vapour as contaminants are shown graphically. The density is 5·1 times that of air so that the rate of diffusion is relatively slow and the gas may be poured into an open container and almost completely displace the air. Only slightly greater electrical spacings are required in SF_6 than transformer oil. T. A. CHALMERS

616.831 : 534.13

4016. The shock effect on a fluid sphere as the basis of a theory of the origin of brain injuries. W. GÜTTINGER. *Z. Naturforsch.*, **5a**, 622–8 (*Nov.*, 1950) *In German.*

A theoretical examination of the pressure distribution in a fluid contained within a rigid sphere which is rapidly accelerated. The differential eq. for free oscillations of the fluid is solved for the case of an impulsive acceleration; the case of acceleration over a finite time is treated by combining a series of impulsive solns. It is shown that a compression wave is set up at the side of the sphere at which the accelerating force is applied, and an equal rarefaction at the opposite side. These increase in strength as they travel inwards towards the centre, so that a very large pressure gradient occurs instantaneously at the centre when they meet. The theoretical results are in general accord with experience, if it is assumed that the brain can more readily withstand a momentary compression than a dilatation. A. SCHOFIELD

PHOTOGRAPHY 77

771.53 : 778.33

4017. Characteristics of some further films suitable for use in industrial radiography. R. L. DURANT. *Brit. J. Appl. Phys.*, **2**, 42–5 (*Feb.*, 1951).

The characteristics of two screen-type films, in combination with both Pb and salt screens, one non-screen X-ray film and two ordinary single-coated photographic films are presented. The results show that Eastman M film has the highest contrast and finest grain of any non-screen film investigated, whilst the slow speed photographic films Ilford Line and Process allow the range of speed to be increased. Although the general use of salt-screen combinations is not recommended, they do increase the speed range very considerably by virtue of their high speed. For the conditions specified, the total speed range available is about 3 000 : 1 for standard development time, and some 100 000 : 1 if development is varied. A.

771.534

4018. Investigation of the anomalous type of ageing of photographic emulsion layers. V. I. SHEBERSTOV. *Dokl. Akad. Nauk, SSSR*, **73** (*No.* 6) 1231–3 (1950) *In Russian.*

Gives the results of an observation of 122 high-sensitivity emulsion layers on nitrocellulose base. The observation lasted 24 months, and sensitometric measurements were carried out every month. It was found that the sensitivity fell continuously and that this fall was not connected with an increase of fogging. It was also found that this anomalous ageing of emulsion occurs predominantly at room temperature, whereas at temperatures around 50°c the normal ageing (the extended ripening type) is more frequent.

F. LACHMAN

771.534.5 : 537.531

4019. Sensitometry in roentgenology. J. F. RODERICK. *Amer. J. Roentgenol. Radium Ther.*, **65**, 109–14 (*Jan.*, 1951).

A description is given of the quantitative method of determining the characteristics of X-ray film during manufacture. The density/exposure curve is studied in detail, and factors affecting speed, contrast and latitude of an X-ray film are discussed. Curves show the change of contrast, and also the increase of chemical fog, with development time. These data are obtained by exposing films to radiation through Al step-wedges, and by reading the gradations of blackening thus produced, with a densitometer. Four types of densitometer in common use are briefly described. Density/exposure curves for similar films irradiated with and without intensifying screens are given. Variation of screen intensification factor with the filtration added to the X-ray beam and with change in excitation voltage, are discussed. D. V. MABBS

771.535 : 778.3

4020. Latent image fading in nuclear emulsions. A. BEISER. Letter in *Phys. Rev.*, **81**, 153 (*Jan.* 1, 1951).

778.3

4021. Liquid-emulsion methods in electron track radiography. D. T. KING, J. E. HARRIS AND S. TKACZYK. Letter in *Nature, Lond.*, **167**, 273 (*Feb.* 17, 1951).

778.3

4022. Track autoradiography with iron-59 and sulphur-35 with quantitative evaluation. D. CAMPBELL. Letter in *Nature, Lond.*, **167**, 274–5 (*Feb.* 17, 1951).

778.3 : 537.591

4023. Cosmic-ray investigations with special photographic emulsions. P. DEMERS. *Canad. J. Res. A*, **28**, 628–55 (*Nov.*, 1950) *In French.*

The technique of the preparation of unsupported layers of emulsion of thickness 150 μ and their assembly into stacks of up to 80 layers is described. The efficiency of such an assembly, measured by the proportion of tracks from a nuclear disruption which can be followed to the end of range, is estimated. Examples of large stars are detailed. New apparatus for mapping events in emulsion layers, for the continuous photomicrography of long tracks and of heavily dipping tracks, and for the orientated exposure of emulsion blocks at balloon altitudes, is described. J. G. WILSON

778.37

4024. Photographic recording of ultra-high-speed phenomena. C. H. JOHANSSON. *Trans Instrum. Meas. Conf., Stockholm* (1949) 132–5 (1950).

"Schlieren photographs" with camera and flash-light, and the rotating mirror methods for the measurement of the velocity of light-emitting processes, such as speed of detonation are described, with applications to explosions of charges, etc. Typical photographs are reproduced. E. H. W. BANNER

778.37 : 531.765 : 621.317.39

4025. Electronics in short-time measurement and high-speed photography. P. NASLIN. *Trans Instrum. Meas. Conf., Stockholm* (1949) 139–49 (1950).

Various forms of electronic chronograph are described, including scales of 2 and 5. Spark generators of the RC type are used for single shadograph exposures. Another electronic spark generator is suitable for speeds of 50 000 frames/sec and various modifications are shown, with examples of results, and circuits. E. H. W. BANNER (R)

778.37 : 621.396.615.17 : 621.327.4

4026. A new power stroboscope for high-speed flash photography. W. D. CHESTERMAN, D. R. GLEGG, G. T. PECK AND A. J. MEADOWCROFT. *Instn Elect. Engrs Paper* 1127, 13 *pp.* [*Early Proof Issue*].

A power stroboscope has been developed for high-speed flash photography at picture repetition rates from 100–4 000 pictures/sec, the duration of each flash being 5 μsec. The control circuit uses a hydrogen thyratron to trigger the tube discharge, and the energy is supplied to the lamp at 12 kV. The storage capacitor of 0·1 μF delivers 4 joules to the lamp. During the development it was found that the light emission from a low-pressure Xe-filled tube persisted for a considerable time after current had ceased to flow. This afterglow in Xe discharges is greatly reduced by an increase in gas pressure and other changes in the physical design of the lamp. The stroboscope can be used for direct photography with a drum camera, or it can be synchronized with the optical compensation element of an image-compensated camera. Some examples of the application of the system to cavitation research are given. A.